THE

INFLUENCE

OF

SEWERAGE AND WATER-SUPPLY

ON THE

DEATH RATE IN CITIES.

By ERWIN F. SMITH.
Ann Arbor, Mich.

[Read at the Sanitary Convention at Ypsilanti, Mich., July, 1885. Reprinted from a Supplement to the Annual Report of the Michigan State Board of Health for the Year 1885.]

[Reprint No. 243.]

THORP AND GODFREY, STATE PRINTERS AND BINDERS, LANSING.

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"*Eine der mächtigsten Stützen der öffentlichen Gesundheit ist die öffentliche Reinlichkeit.*"—Jos. von Fodor.

"*Ce qui est dangereux, ce n'est pas la matière excrementielle qui entre dans l'égout et s'y noie, c'est celle qui n'y entre pas.*"—MM. Vallin et Hudelo.

NOTE.

In this paper no effort has been made to present anything new. The most I have essayed is to put a body of more or less inaccessible data into a form suitable for easy study and comparison. My ability to do this has been greatly increased by the courtesy of sanitarians at home and abroad to whom I desire to express thanks. The foreign statistics are especially interesting and valuable through the kindness of Drs. Max von Pettenkofer, G. Varrentrapp, Alex. Spiess, Joseph Körosi, de Pietra Santa, C. Albenois, and others who not only furnished very complete mortuary data for their own cities, but also kindly gave other needed assistance. So far as possible, the statistical tables have been made to cover the entire period during which records have been kept down to the year 1884 inclusive. Only the most reliable data have been used, and these have been computed, proved, and tabulated with the utmost care.

The reader will note a paucity of American statistics and possibly wonder why I should go abroad for so much of my illustrative material. This was unavoidable. Of statistics, so-called, we have an abundance, but of really valuable mortuary data, comparatively little. The mortuary records of most of our cities cover so short a period or have been kept in such a slip-shod manner, if kept at all, that they are of no value whatever to the sanitarian. Some American cities, known to be in a very insalubrious condition, have nevertheless declared officially from year to year a surprisingly low death-rate,—a rate in some cases much lower than that of the cleanest and most salubrious cities. The inference is that these cities have either overestimated their population in the years between the official censuses (a prevailing American habit), or have only very imperfect methods of determining the exact number and nature of the deaths. In some instances which have come under my observation, both causes have unquestionably combined to vitiate the records. It is unnecessary to add that I could make no use of such "statistics."

The sanitary importance of carefully kept records of births, deaths, and the movements of population is so great that one cannot refrain from regret that the subject does not receive more extended and thoughtful consideration. A high death-rate implies an unnecessary waste of human life. The nature and extent of an evil must, however, be known before any remedy can be applied, and in the case of the death-rate, if the necessary, careful records are not kept, there is no sound basis for judgment as to whether the mortality of a city is high or low, increasing or diminishing. The citizens may rest in false security, believing the death-rate to be low when it may really be unnecessarily and excessively high so that no man's life is as secure as it should be. Again, we may be asked as to the healthfulness of a city with whose insalubrious condition we are familiar. What answer shall we give? Basing our judgment upon the records of other localities where similar conditions prevail, we may be morally certain that in that city there are 300 or 500 deaths a year from removable causes, yet we can-

not show this in black and white, and drive the solemn truth home upon the citizens in such a way as to produce action, unless we can appeal to authoritative records. If we can do this, we may confidently look for good results. Sanitary improvement is rife in Michigan, but our needs more than keep pace with our advance. The sanitary condition of our cities, it may be said, is as good as the average. This may or may not be true. We have no means of judging so long as the records are defective; but, even if the premise were granted, the argument proves nothing, since simply to be as well off as others, is, in this case, to be poor in common sense and blind to personal safety and public interest. If we should outstrip our neighbors in sanitary reform, no one would have cause for regret. It is at present impossible to determine the death-rate, with any degree of accuracy, either for Michigan as a whole or for any city in it, with possibly three or four commendable exceptions. Suitable regulations, State and municipal, for the collection of vital statistics, are greatly needed. We shall never know exactly where we are or what we need in a sanitary way until we have greatly improved our registration laws. At present the State law is such that the deaths of one year remain uncollected and unrecorded until the beginning of the next year. These records, once made, suffer an additional delay of a half year or more in the offices of the county clerks from which they are finally transmitted to the registration office, in the form of copies, subject, of course, to the additional errors arising from careless transcription.

The neglect of vital statistics in this country is very general, and certain "smart" legislators and newspaper men, whose ignorance is only equalled by their conceit, consider it quite the thing to cry down all statistical work as a waste of time and public money. In this way the public are misled and the neglect is fostered. In recent years my attention has been called to this subject repeatedly, and especially during the preparation of this paper have I had frequent occasions to regret the lack of necessary data. I could not, for example, compare certain interesting features in the mortuary records of New York, Chicago, Baltimore, and New Orleans with the records of their respective States, because the great States of New York, Illinois, Maryland, and Louisiana have never considered it worth while to keep mortuary records, although it has been demonstrated over and over again that a wise expenditure of public money in this direction would bring large returns. Massachusetts, Vermont, Connecticut, Rhode Island, and Michigan are the only States which have published anything worthy the name of Registration Reports, and in these States, Massachusetts excepted, the laws governing the collection of the vital statistics are more or less imperfect and unsatisfactory.

The substance of this paper was presented at Ypsilanti July 1. The subject has been under careful consideration for a good portion of a year, but the author is sensible of numerous imperfections. Those who have carried on similar inquiries can best appreciate the labor involved, and will be best able to judge of the results obtained. Allowing for errors of omission and commission, which will undoubtedly be found, it is hoped notwithstanding that the paper will prove useful, if in no other way than as an incentive to further study of an important but very generally neglected subject. Several years of continuous labor could be profitably devoted to any one of the topics upon which I have touched. The field is open to all and is more than ordinarily inviting. Sanitary science is the coming science. It is the most recently developed of the sciences because it is based upon all the others. Mathematics, physics, chemistry, biology, statistics, are all tributary to it. What has been done is but a tithe of the beneficent work which can be done and will be done in the years to come. Length of days with comfort and contentment follow in its train. Sanitary science will be neglected wherever a low estimate is put upon human life. It will be given a large place and generous treatment in proportion as the value placed upon life increases. This science is yet in its infancy; but, as life in civilized communities is constantly assuming new and higher values, some of us will undoubtedly live to see chairs of sanitary science established in all our universities, and the fundamental principles of the science taught in all the common schools. Sanitary science is a large theme. Its fit presentation demands the best brain and the readiest pen. Its truths come home to every man. They require only to be clearly developed and forcibly presented to become generally accepted and applied. The army of sanitary workers increases every year, and the advance is sounding all along the line. If this paper adds even a little to the momentum of this onward movement, I shall be abundantly satisfied.

In conclusion, I must crave the reader's patience to the end, since a paper of this sort is necessarily lengthy, and in parts at least, likely to appear repellent,—"as dry as statistics" having unfortunately crystallized into a proverb that passes current unchallenged.

Ann Arbor, Mich., December 1, 1885.

I.

From time immemorial some method of sewage disposal has been considered a necessity of civilized life, but only within recent years has sewerage been reduced to a scientific basis. During the Middle Ages, not to push our inquiries further back, the Scotch and English cities were in an abominably filthy condition,* and in continental cities the ignorance and neglect of sanitary require-

* The Sewage Question. Krepp, London, 1867, p. 7. History of England. Macaulay, vol. 1, chap. 3.

ments were, if possible, even greater. Filth of all sorts was allowed to remain in and around the houses for years together, or was thrown into the street with little thought of ulterior consequences. In England the floors of the rude houses were commonly strewn with dried rushes, in lieu of mats or carpets. When these became saturated with filth, past the endurance of our ancestors (who, with all due respect, we must admit were none of the cleanest), another layer of rushes was thrown down over the old one, until the rank accumulations of years often reached a depth of several feet. In London and Edinburgh it was not safe for decently dressed people to pass along many streets, owing to the danger of being deluged with slops inadvertently thrown from upper windows. On the continent, at Amsterdam, Rotterdam, Paris, Marseilles, Naples, etc., there was no attempt at sewerage; the indiscriminate filth of men and animals lay uncared for in the houses and yards and leached into the surrounding soil. In the larger and more crowded cities the universal nastiness exceeded all description.

The natural inertia of human nature, combined with Middle Age ignorance and superstition, formed an effectual barrier to all sanitary progress. Nature is a kind mother only to obedient children. To all others she is merciless, exacting the last farthing of penalty for infracted law. Our ancestors did not escape. The plague,* the sweating sickness, typhus and kindred disorders swept over Europe time and again, devastating great populations, sweeping away whole villages like chaff before the wind. The idea of any close relationship between filth and pestilence never seems to have occurred to our ancestors. They importuned Heaven for relief with prayers and fasting, but never sought refuge in clean linen or discovered the sanitary virtues of fire and water. The heavens were deaf to prayers and tears, but occasionally some happy accident came to man's rescue, as when the great fire of London put an end to the scourge by destroying the plague centers. We of the nineteenth century better understand the laws of contagion, and have profited by the bitter experience of the Middle Ages. To-day no educated person is rash enough to dispute the value of sanitary works, and yet great ignorance prevails even among the educated as to the *extent* of their value. Among the uninformed and half-educated there is even in some instances a belief that sewers *cause sickness*, and upon the whole are more dangerous than beneficial. The general belief, however, based in this instance upon exact knowledge, is that some system of sewerage is a necessity. What, then, shall it be?

II.

The removal of waste products from the interior to the exterior of the habitation, without further thought, is the simplest and most ancient method of sewage disposal.

This method is suited only to the most primitive state of society. In civilized communities it usually gives rise to a nuisance second only to that which arises from leaving the refuse uncared for within the dwelling.

Experience gradually led to the use of middens, vaults, and similar special places of deposit.

* Boccaccio, in the introduction to his *Il Decamerone*, says that in Florence alone upwards of 100,000 persons perished by the Black Death between March and July, 1348. Italy, says Rochard, was almost depopulated. Geneva lost 40,000 inhabitants, Naples 60,000, Venice 70,000. In the brief space of four years all Europe was scourged, and it is estimated that not less than 40,000,000 perished. In 1665, in London, no less than 100,000 died of this disease. Marseilles suffered a terrible epidemic as late as 1720, Moscow in 1771. It appeared also in Malta in 1813, and in the Balarics in 1819. This disease is still present in Western Asia, and it even invaded certain fishing villages on the shores of the Volga as recently as 1878. See Pepy's Diary, vol. ii. Hecker's The Black Death in the 14th century, Chap. iv. Rochard's *La Valeur Economique de la Vie Humaine, etc., C. R. and Mem. du Cong. Int. d'Hygiene*, tome i., p. 72, etc.

The influence of these middens, cesspits, and vaults on the air, the soil, the ground-water, and the water of neighboring wells has often proved so dreadfully mischievous that this crude method nowhere meets with any favor on the part of sanitarians, although it is still in common use in Europe and America. Wherever there are crowded populations using this method, there cholera, typhus, typhoid, or yellow fever will be found to prevail with alarming and dreadful regularity.

The poisoning of the air, the soil, and the water by human excreta produces a condition very favorable to the propagation of cholera and the deadly fevers. Bring about this condition and an epidemic or pestilence may be predicted with about as much certainty as an eclipse, whenever chance shall bring the germs of any of these diseases into the midst of such a community, since they (the germs) find in the foul subsoil and water exactly those conditions necessary to their rapid growth. The introduction of the infection of typhoid fever or of cholera into such a community may be likened to the bringing of fire into contact with gunpowder. All the elements save one of an epidemic explosion are under our feet in such a soil, are in the air we breathe, or in the water we drink. As the unstable gunpowder waits only the touch of the magic spark to shake the earth with its liberated fury, so the foul soil and water waits only the appearance of the germ of cholera or fever to become equally destructive. A city with pure air, pure water, and clean subsoil, has nothing to fear. To continue the metaphor, such a city is like an arsenal from which all the explosives and combustible materials have been carefully removed. Let then the flame search every nook and cranny of the great building, no explosion will result. In such a city (however often cholera or typhoid germs may be imported) we may rest secure, because one factor is wanting without which there can be no general epidemic. This factor is filth, and especially a filthy soil. Passing by the pit or midden method of sewage disposal, which is no method at all, and deserves mention only to be unsparingly condemned, let us consider briefly the various methods which sanitary and engineering science have devised. These may all be classed under two heads:

1. *The conservancy system*, including:
   - *a.* Dry earth closets.
   - *b.* The pail or tub system.
   - *c.* Cemented vaults, exterior to houses.
2. *The immediate removal system*, including:
   - *a.* Water-carriage system (separate or combined).
   - *b.* Pneumatic sewerage systems.

Cemented vaults, situated in yards and cleaned periodically, are in use in many American and continental cities. Where such vaults are carefully built and frequently cleaned good results have been obtained, as in Leipzig, Dresden, Stuttgart, etc. Other cities, such as Manchester, Rochdale, Paris, use in part, or entirely, a tub or pail and cartage system, employing scavengers who remove the excreta once or twice a week, as the case may be.

The "dry earth system," advocated in England by Mr. Moule and so warmly recommended in this country some years since by Col. Waring in his pamphlet "Dry Earth," has been tried on a small scale in various places, and for individual houses or small towns can, with proper attention, be made safe and efficient. It cannot, however, be applied on a large scale, and, even if it could, would be inferior to water-carriage.

Mr. J. W. Adams, C. E., in an interesting paper published in the Report of

the State Board of Health of New Jersey (1882, p. 72), concludes that to obtain the best results from the use of earth-closets would require a ton of earth per year to each individual. His es imate appears to be rather too high. Dr. Chalmers in a recent paper* estimates one and one-half pounds of earth per day as necessary for each healthy person. This estimate is considerably short of the amount required for persons sick of diarrheal diseases. It does not appear practicable to use the earth repeatedly, and the expense of carting earth to and from a large city, even accepting the lowest estimate of amount necessary, would of itself render the method impracticable, even if the earth could be obtained in quantity. The procuring of earth would be another insurmountable difficulty, since the removal of the surface soil from hundreds of acres would encroach too much on the domain of agriculture. Dry and finely pulverized clay should be used in earth-closets. Coarse sand or gravel is of no value.

As ordinarily managed, the earth-closet and all other conservancy methods become a nuisance, only to be tolerated where sewerage proper cannot be secured. On the relative value of the water-carriage and the conservancy systems I may quote from a recent valuable paper by Corfield, who has given the subject careful attention and who voices very substantially the opinion of the great body of English sani arians:

"There is still a great fallacy abroad in connection with the question of the removal of refuse matters in the vicinity of habitations. People talk and write as if the water-carriage system and the conservancy systems stood upon the same footing,—the principle of the one being the immediate removal of excretal matters from houses, and that of all the others being, as their name indicates, the keeping of such matters in and about the house for a certain time. The one is a correct principle, the other is a false one, and it is no argument at all to say that where the water-carriage system is badly carried out the result may be worse than where the conservancy system is carefully managed. In sanitary matters, as well as in everything else, we should follow correct principles. If we do not, but by arguments equally specious and fallacious, try to persuade ourselves that 'practically speaking' (according to the cant phraseology of the day), better results may be obtained by following false principles, nothing is more certain than that by an inexorable law of nature true principles will assert their position, and we shall be punished for our mistake by being landed in difficulties greater than we had to contend with at the outset. It is a very old and often exposed fallacy to argue against the use of a thing from the abuse of it, and to argue against the water-carriage system because surface drains have been called upon to do the duty of sewers, for which they were not intended, and of which they are not capable, or because the sewage has been turned into the water-courses, which have thus become unfit to supply water for domestic purposes,—is an excellent example of this kind of fallacy. I do not say that a well-managed conservancy system is not better than a badly managed one, nor far better than no system at all, nor do I say that there are not places where the difficulty of carrying out a water-carriage system is not so great as to be almost, if not quite, insurmountable; but I do say that in towns where a water-carriage system is possible, there is no room for choice in the matter."†

The pneumatic system may be passed by with simple mention, as not in use in this country and but to a limited extent in Europe. It has been used to advantage in certain low-lying Dutch cities, where it has reduced the death-rate, and it is applicable in localities where water-carriage is impossible. It requires separate systems for rain water and sewage, and, owing to its expense and to other reasons, English and continental sanitarians have not taken kindly to it. One reason, possibly, for prejudice against the system has been the unfair and indefensible methods of its adherents. Those who desire to learn the merits of this system should consult the writings of Dr. Overbeck de Meyer,‡ one of its ablest defenders; of Krepp,§ Zehfuss, etc.‖

* On the Earth Closet System in Epidemic Hospitals. By A. K. Chalmers, M. B., Mossend, late Physician-Supt., Joint Burgh's Hospital, Maryhill, Glasgow. San. Jour., Glasgow, May 11, 1885.

† "Sanitary Fallacies." By W. H. Corfield. Tr. San. Inst. of Gr. Br., Vol. I., 1880, page 244; also "Sanitary Record," Vol. I (New Series) page 205.

‡ *Les Systems d'Evacuation des Eaux et Immondices d'une Ville*, 138 pages. Paris, 1883. Also a pamphlet by same author, with similar title, published in Paris in 1880.

§ The Sewage Question. Krepp. London: Longmans, Green & Co., 1867.

‖ Pneumatic Sewerage, pam.

The remaining method of sewage disposal, and the one which has furnished the basis for most of the argument in this paper, is the water-carriage system, now in use in New York, Brooklyn, Boston, Chicago, London, Munich, Hamburg, Dantzic and many other large cities

Edwin Chadwick, John Simon, Douglas Galton and all the most eminent English sanitarians, have frequently argued in favor of the water-carriage system, declaring it to be altogether the safest and best. There appears to be no reason for disputing their dictum, since it is in accord with the most recent conclusions of German, French and American authorities.

Data drawn from sewered cities is now available for study and comparison. To be of service such data must have been carefully gathered and must cover a considerable period; the population must be known to have been correctly enumerated, and various other factors which enter into every consideration of the death-rate of a place, such as race, age, condition in life, crowding, occupation, etc., must be given due weight. Taking all these factors into consideration, and cas ing up accounts, there remains a striking balance sheet in favor of the sewered cities.

In the consideration of this subject the general propositions which I wish to lay down, and which appear to me to be clearly deducible from the data at my disposal, are as follows:

1. Typhoid fever and cholera decrease in proportion as a city is well sewered.
2. There is no direct relation between diphtheria and sewers.
3. The general death-rate falls after the sewering of a city, and, other things being equal, never again reaches the maximum of its ante-sewered condition.
4. The cost of building and maintaining sanitary works is inconsiderable in comparison with the direct pecuniary loss, by sickness and death, which their absence entails.

III.

Cholera and typhoid fever decrease in proportion as a city is properly sewered. This may be laid down as a fundamental proposition, to which there are no exceptions. The apparent exceptions will be considered in their place. They are so slight and easily explained, however, as not to affect the general law or to require attention, save to silence those who furiously denounce everything bearing the name of sewers, and blindly oppose their own interests by ascribing *to a system* what belongs only to its misuse or abuse. Drains, im erfectly jointed and lacking the proper facilities for flushing, or the necessary fall for the introduction of excreta and for proper clearing, are in no proper sense of the word *sewers*, and are not considered as such in this paper. If excreta be introduced into such drains it almost always proves a public nuisance, and the writer is far from denying that under some circumstances such drains, "sewers," so-called, may not become active promoters of infectious diseases. When I speak of the benefits arising from sewerage I mean, invariably, modern sewers, well-buil , well ventilated—the soil-pipes, traps, water-closets, etc., being constructed on approved plans and in the most workmanlike manner.

My reason for selecting typhoid fever is that, although the nature of the typhoid poison is yet in dispute, we now understand very clearly the manner in which the disease is spread Another reason is the gravit of the mortuary tax levied by typhoid fever. This will be at once apparent if we consider briefly the statistics of this disease.

The typhoid deaths returned in Michigan are about 500 per year, which number, owing to the imperfect machinery of the registration, is only about one-half

the actual number of deaths. Taking 1,000 as the annual typhoid mortality of Michigan, the corresponding cases of sickness may be roughly estimated at somewhere between 10,000 and 15,000. The mean annual typhoid mortality of Massachusetts during the past twenty-seven years has been 1,080. This would give for the entire period—1858–1884—28,900 deaths, and in round numbers somewhere between 300,000 and 400,000 cases. In the kingdom of Saxony* during the ten years, 1873–82, in an average population of 2,845,000, typhoid fever caused a mean yearly destruction of 921 persons. During the same period, in round numbers, there must have been in the neighborhood of 100,000 cases.

According to Dr. W. J. Simpson, Medical Officer of Health of Aberdeen, the total typhus and typhoid deaths in Great Britain during the ten years, 1860–70, amounted to 221,369, of which 184,386 were in England and 36,983 in Scotland.†

According to the last published report of the English Registrar-General (Table 40), the average fever deaths in England for thirty-four years (1850–1883) have been 15,244. This gives a grand total for the thirty-four years of 518,296 deaths. To get the cases this number should, at least, be multiplied by 10.

I have chosen to consider cholera for the same reasons that led me to select typhoid fever: (1.) The destructive nature of the disease, (2) its frequent wide prevalence, and (3) its similarity to typhoid fever as regards method of spread.

The mortuary tax levied by cholera is very grave. According to Rochard‡ cholera has visited France six times during the last half century. The first three epidemics, 1832, 1849 and 1853–4, caused 346,478 deaths in an average population of 34,839,356, and the first five epidemics at least 400,000 deaths. Laveran's statement of the French loss in the first three epidemics is substantially the same as Rochard's, being 100,000 for 1832, 110,000 for 1849, and 143,478 for 1853–4. The deaths from cholera in England in 1848 were over 72,000 in a population of 20,000,000. The deaths in Austria in 1855 were 274,324 in a population of 28,000,000. In Spain and Portugal the same year the deaths exceeded 236,000 in a population of 15,151,000.

In Russia, in 1847–8, the cholera cases exceeded 300,000 and the deaths 100,000 in a population of 12,000,000. In Prussia, in 1852, there were 40,340 deaths in a population of 9,119,563. In Italy, in 1865, there were 12,901 deaths in a population of 3,677,000.§ Rochard estimates the total deaths in Europe from the first three cholera epidemics at 3,400,000. Another statistician, Dr. Vacher, estimates that cholera carried off about one-half million persons in Europe in 1865–67. His exact figures are 478,271.‖ An ocean and a continent lie between us and the home of cholera, but we have not escaped. In 1832 the cholera deaths in Havana numbered 10,000; in New Orleans (variously estimated) between 4,000 and 7,000; in Quebec over 2,200; in Montreal over 1,800; in New York city 3,513. In 1849, in New Orleans, cholera numbered 3,176 deaths; in New York, 5,071; in St. Louis, 4,317. In St. Louis, in 1866, there were 3,527 deaths from cholera in a population of 204,000, being 17 to each 1,000 inhabitants. In some of the smaller American cities the ratio of deaths to total population has been even higher than in St. Louis.

* Kalender and St. Jahrbuch f. d. Königreich. Sachsen, 1885. Pg. 207.

† Glasgow San. Jour., Jan., 1885, p. 323.

‡ *La Valeur Economique de la Vie Humaine, et sa Comptabilité.* Par M. Jules Rochard de Paris. Pp. 62-95 of Tome I. of the "*Comptes Rendus et Mémoires du Vme. Cong. International d'Hygiène et de Démographie* à La Haye. Aug., 1884.

§ Cholera, Laveran. *Dict. Encyc. des Sci. Médicales.* Première série, tome 16, second partie. Paris, 1875.

‖ Statistique du Cholera de 1865 à 1867 en Europe. Par M. le Dr. Vacher. *Jour. de la Soc. Statistique de Paris.* 1868. Pp. 165–176.

It thus appears that no inconsiderable portion of the general death-rate is due to cholera and typhoid fever. The subject is therefore intrinsically important. Add to this intrinsic importance the fact that cholera and typhoid are diseases which perfect sewerage, drainage, and water-supply would banish from civilized life, and the subject becomes one of all-absorbing interest.

TYPHOID FEVER.

The etiology of typhoid fever is not settled. There are various theories as to the exact way in which it arises and is propagated. According to some authors the disease never arises independently of a specific typhoid organism (Budd, Liebermeister, and many English and American writers). According to others (most of whom do not deny that the disease may arise at times from infection due to previous cases) the disease is believed to be due more frequently to poisoning by ordinary fecal matters or to malarial or other influences not clearly defined. This is the origin *de novo* of Murchison, and various French and American writers.

The exact way in which the poison enters the body is also in dispute. There is: (1.) The drinking water theory (Budd, *et al.*) (2.) The air infection theory (ground air, Pettenkofer; sewer air of authors).

I am inclined to believe the disease never arises independently of a specific germ, and that it is ordinarily introduced into the body with the drinking water. This view seems most in harmony with all the facts, but for the purposes of this paper it is immaterial whether typhoid fever arises *de novo* or from a specific germ, or whether it be spread solely by infected water, or by both water and air, since if the sewage of a town be rapidly and completely removed, the air, the soil, and the water can become infected neither by specific micro-organisms, nor by the ordinary bacteria of putrefaction. It has so long been well understood that the infection of the drinking water and the fouling of the air by human excreta is the direct or indirect cause of typhoid fever, that it has very generally received the name of "filth fever."

The nature of the typhoid poison and the way in which it spreads explains why cities destitute of general water-supply and proper sewerage suffer more from this disease than their more fortunate or enterprising neighbors. In such cities it is customary to draw the drinking water from shallow wells or defective underground cisterns, the waters of which are always more or less tainted with the ooze from vaults and drains. If by chance typhoid excreta is thrown into the vaults or drains the poison may often find its way into such wells and cisterns through a readily permeable soil, with results most unexpected and disastrous to those who drink. There is an intimate relation between typhoid and a soil defiled by excrementitious matters. Such a soil becomes a breeding place for low vegetable organisms. These micro-organisms find their way through the porous soil into cisterns and wells, and are drawn out of the soil by fluctuations of barometric pressure and changes of temperature into the lower layers of the air, and into our houses. Speaking of the evils of a foul sub-soil, Capt. Douglas Galton says:*

"In cold weather the temperature of a house is warmer than that of the outer air. If a house is built on soil containing deleterious matters, the impure air will be drawn into the house by the action of the warm air of the house." * * * * "It would be just as healthy (indeed, probably far healthier,) to live over a pig-sty than over a site in which refuse has been buried, or in which sewer water has penetrated, or over a soil filled with decaying organic matter."

Everywhere this connection between foul subsoil and typhoid fever has been

* "Sanitary Engineering." By Douglas Galton. Sanitary Record, Nov. 15, 1879, p. 169.

observed, and repeatedly pointed out,* and the general high typhoid death-rate of twenty and thirty years ago, now happily modified in many places can be attributed to no other cause than the abominable fouling of earth, air, and water by human excreta. There has been a great change for the better in the sanitary administration of cities since 1850, and in nothing is this more noticeable than in the care bestowed on sewage disposal and on the public water supply.

In a letter to the author, Dr. Alex. Spiess, of Frankfort, states that in the larger German cities there has been a falling off of typhoid in recent years irrespective of sewerage and water-supply. Statements of this kind have been frequently made of late by high authorities in sanitary science. I am prepared to admit the fact that there has been a marked falling off of typhoid in many cities, but not in all. My own inquiries lead me to think the diminution has been in each case conditioned on improved sanitary conditions, notably the introduction of sewerage and water-supply. So far as I can learn the cities which have no sewerage or proper water-supply are scourged by cholera and typhoid fever as badly to-day as were the general run of cities twenty or thirty years ago, putting aside, of course, those yearly fluctuations of the typhoid mortality, always more or less noticeable, and dependent upon seasonal and other influences. If the reader will consult the tables appended to this paper, or Chart II which gives in a graphic way the results derived from these tables, he will see at once that this is true. There has been no very material reduction in recent years in the cities included in Group II of this chart, nor in the cities of Riga, Moscow, Madrid, Toulon, Mexico, Guayaquil, Cairo, etc. The typhoid reduction noted has been most marked in England and Germany where public health interests have received great attention during the last decade. It has been least marked in such countries as Mexico, Russia, Spain, and Italy, where until very recently no advance has been made in practical sanitation.

If typhoid fever has decreased in proportion as sewers have increased, is it an unwarranted inference, knowing what we do, to attribute the decrease to the sewers? *A priori*, this is what we should expect, and *a posteriori*, this is what we find to be true. As already indicated, we also find the reverse of this true.

The view has been advanced by Dr. Varrentrapp and others, that typhoid fever is naturally a disease of the country rather than of the town. The data at my disposal appear to confirm this only in part. Wherever this is true, it would seem reasonable to ascribe it to the more active sanitary life of the large cities, rather than to any unknown telluric influences. Great carelessness in the disposal of excreta is prevalent in small villages and country districts, and the water-supply is usually drawn from shallow wells in proximity to various kinds of filth.

Ever since typhoid fever was clearly distinguished from typhus fever it has been observed that certain cities, and certain localities in cities, are more subject to the disease than others. The permanent fouling of the subsoil, and consequent infection of the air and water, explains these repeated visitations. We now know that the disease will usually appear in such places as often as the typhoid poison finds its way through the old channels into the drinking water, or into the air habitually breathed.

Good sewerage undoubtedly improves the general healthfulness of a com-

*Liebermeister says: "In general, we can say that the disposition of any locality to an epidemic of typhoid fever depends largely on the extent to which the inhabitants breathe or drink the contents of their privies. The greater the chances of this are, so much the greater are the probabilities that the introduction of an imported case of typhoid will produce an epidemic." *Ziemssen's Cyc.*, Vol. I, pg. 35.

munity, and renders many diseases less virulent, but its most striking influence is on the so-called "filth diseases," of which typhoid may be taken as a type. Wherever sewers, conforming to the requirements of modern sanitary engineering, have been introduced, typhoid and kindred diseases have fallen off from one-half to nine-tenths. This result has been so constant and is so important that it may well be considered in some detail.

In Munich the mean typhoid death-rate was formerly twenty-four to each 10,000 living. This was prior to 1859 when there was no municipal supervision of the sewage. The night-soil was received into vaults under or near the houses, and from these found its way readily into the sub-soil. The following description of the sewage disposal of that time is sufficiently exact: "Many of the privies in private dwellings extend like huge chimney-shafts from the tops of the houses with openings on every floor down into the cellars where they end without any sewer connection or water flushing." The air in the houses was always bad, especially at night when the doors and windows were shut. There was a well in nearly every yard, and this generally received the ooze of vaults, refuse-heaps, and drains. The citizens avoided the well water, when possible, and strangers were warned not to use it.* From 1859 on, more and more attention was given to the disposal of night-soil by the urban authorities. Owners were required to cement tightly the bottoms and sides of cess-pits, and to see that they were kept in better condition and periodically cleaned. Many foul privies were removed from the houses and disgusting vaults from the cellars.

This produced a cleaner soil, and this in time had a marked effect on the typhoid mortality which fell away noticeably after 1859. With the partial introduction of sewerage into Munich the mortality continued to decrease. The reduction as given by Pettenkofer, Wagus, and Soyka may be stated as follows:

DEATHS FROM TYPHOID FEVER PER 10,000 INHABITANTS IN MUNICH.†

1854 to 1859 when there were no regulations for keeping the soil clean, 24.20; 1860 to 1865 when reforms were begun by cementing the sides and bottoms of perous cess-pits, 16.80; 1866 to 1873 with partial sewerage, 13.30; 1874 to 1880, sewerage works continued, 9.26; 1881 to 1884, sewerage continued—considerable portion of the outskirts of the city still unsewered, 1.75.

In 1880, according to Soyka, 320 out of 453 streets were still without sewers, the per cent of population living in the unsewered parts of the city being 44.6. For the entire period charted by Wagus‡, 1851–1867, the average annual typhoid mortality was 18.2 per 10,000 living. Comparing this with 1 7, the mortality of the last four years, we find a falling off of more than nine-tenths, the annual saving of life thereby being at least 369 persons in an average population of 235,000.

The mortality of the sewered and unsewered districts of Munich during the

* See an interesting account of the sanitary condition of Munich, based on personal observations made in 1842 and in 1857, by Dr. Jno. C. Peters, in "*Cholera Epidemic of 1873 in the United States.*" Washington, 1875, Gov't Press.

† Dr. O. Bollinger, in a recent article "*Die Abnahme des Typhus in München,*" *Allgem. Zeitung*, March 21, 1885, presents the same data in a slightly different form. His figures are: *Typhoid deaths in the civil population of Munich per 10,000 living:*

1852–1859	24.2	1880	6.4
1860–1867	16.6	1881	1.8
1868–1875	12.7	1882	1.9
1876	6.8	1883	1.8
1877–1879	7.8	1884	1.4

‡ Table I. *Zeitschrift für Biologie*, Bd. IV.

period 1866 to 1880 is the subject of a recent memoir by Soyka.* This paper is one of the most interesting in recent sanitary literature. Studying the typhoid mortality critically with reference to situation, crowding, movements of population, etc., in sewered and unsewered districts, Soyka found a considerable balance in favor of the sewered portions, in spite of the fact that they rest on a soil more favorable to typhoid than the present unsewered districts. His conclusions, after a most critical and elaborate study are, that if the sewered portions of Munich were still unsewered the typhoid fever mortality therein would now be very great. In all his comparisons he puts the period 1866–80 over against that of 1875–80. If the period 1866–74 be placed over against that of 1875–80, the contrast is much greater.

Pettenkofer long since† clearly established a relation of movements of the ground-water to the yearly fluctuation and to the autumnal increase of typhoid fever in Munich. In a number of other localities a similar relation of interdependence has been found. More recently Pettenkofer has stated that the fluctuations of the ground-water have no influence whatever on typhoid *so long as the soil is clean.*‡ He adds that for the last ten years the rhythmical variation of high ground-water and low typhoid, low ground-water and high typhoid, which was so apparent at Munich in the past, has almost wholly disappeared, and as regards the last five years, has ceased. This may be seen very clearly from the following table:

Typhoid Deaths in Munich 1881 *to* 1884. *Average Population* 235,000.

Year.	January.	February.	March.	April.	May.	June.	July.	August.	Sept.	Oct.	Nov.	Dec.	Total.
1881	5	6	5	3	5	3	1	1	7	1	4	2	43
1882	2	1	8	4	4	3	4	1	1	6	4	4	42
1883	4	1	2	1	1	4	2	5	3	8	10	4	45
1884	4	2	4	1	.....	1	3	3	7	2	5	3	35

The application of the English sewer system to the city of Berlin began in 1871–2, when the great collectors were built. In 1873 and 1874 sewers of the second order were constructed, but not until after 1876 were any considerable number of houses united to the new system. Up to 1880 only about one-fifth of the Berlin houses had been connected with the sewers. Previous to the introduction of the English system the old style of privy-pit was in general use, and the water-closets in many of the houses emptied, not into the sewers, but into cess-pits or upon the ground.§ The work of sewering Berlin is progressing rapidly and it will soon be one of the best sewered cities in Germany. That such is not the condition at present is shown clearly enough by the increase of typhoid in August, September and October of each year, just as was formerly the case in Munich and is still in all localities where the soil is saturated with excretal filth. However, a great sanitary advance has been made, as indicated by the mortuary records. The typhoid mortality has fallen off two-thirds since

* *Untersuchungen zur Kanalisation. I Kapitel. Mortalitätsverhältnisse München mit Rücksicht auf die Kanalisation.* Von Dr. J. Soyka. Pp. 153. Munich: R. Oldenbourg, 1885.

† Boden und Grundwasser, etc. Munich, 1869.

‡ "In einem *reinen* Boden kann Feuchtigkeit und Trockenheit wechseln, wie sie will, der Typhuskeim findet stets nur wenig oder keine Nahrung."—Letter to the author, March 7, 1885.

§ *Les Systems des Evacuation, etc.* Dr. O. de Meyer. Paris, 1883, p. 39.

the year 1878, the mean annual typhoid death-rate since that date having been only 2.9 per 10,000 living. That this rate is capable of still farther reduction is shown by the above-mentioned autumnal recrudescence. A study similar to that of Soyka at Munich, but not so complete, has been made at Berlin, from which it appears* that, as regards both typhoid fever and diphtheria, a difference was found in favor of the sewered districts. It is stated that in the houses with direct sewer connection there were in 1879, per each 10,000 inhabitants, only 15.5 cases of typhoid fever and 4.5 deaths; in 1880, 20.4 cases and 6.6 deaths; while in the houses not having sewer connection there were in 1879, per each 10,000 inhabitants, 56.0 cases and 17.9 deaths; in 1880, 106.9 cases and 26.2 deaths.

A careful study of the influence of sewers on the reduction of typhoid at Berlin has been made by the city board of health, but is not yet ready for publication. The following interesting facts are gleaned from a recent paper on "The Sanitary Improvement of Berlin,"† by the eminent French engineer, M. Alfred Durand-Claye:

M. Durand-Claye states that recent statistics gathered by various persons, and notably by Dr. Skrzerzka, medical counselor of the government, have shown that there has been a decided improvement in health, particularly as regards typhoid fever, coincident with the improved sanitary condition of the city. It has been shown that in the houses connected with the sewer system the typhoid cases have fallen to 1 or 2 per cent, and the deaths to 0.4 or 0.7 per cent, while in houses not so connected the figures are 6 to 11 per cent for the cases and 1 4 to 2.3 for the deaths. The same results are shown in another way as follows:

CITY OF BERLIN—DISTRIBUTION OF SICKNESS FROM FEVER IN SEWERED AND NON-SEWERED HOUSES.

1. In non-sewered houses, 1 case to each 9.3 houses.
2. In sewered houses, 1 case to each 49.3 houses.

CITY OF BERLIN—DISTRIBUTION OF DEATHS FROM FEVER IN SEWERED AND NON-SEWERED HOUSES.

1. In non-sewered houses, 1 death to each 43.0 houses.
2. In sewered houses, 1 death to each 137.5 houses.

The period covered by these statistics is not given by M. Durand-Claye. The same author adds that the internal sanitation of Berlin is being prosecuted and completed in a most satisfactory manner. The municipality has nothing to regret in having exactly followed, by the advice of Virchow, the methods previously used in London and Brussels, i. e., the direct discharge of all the excreta, household slops, and rainwater into well ventilated sewers.‡

The sewers at Frankfort on the Main were begun in 1867 and completed in 1876.§ The typhoid death-rate prior to 1876 averaged about 7 per 10,000. Since the completion of the sewers it has fallen off over three-fourths (See table XVIII). According to Dr. Kraus, quoted by Dr. O. de Meyer (pg. 42 *Les systems d'evacuation des eaux et immondices d'une ville*, Paris, 1880), the cases of typhoid fever in Hamburg during the three years 1872, 1873, 1874, were on an average per 10,000 inhabitants:

(1.) In the four divisions of the city almost completely sewered, 26.8.

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* *Journal d'Hygiène*, Paris, 1885, No. 437.
† *Revue d'Hygiène*, Paris, April 20, 1885, pp. 295-304.
‡ See striking conclusions of Dr. Fodor at Buda Pesth under section devoted to cholera.
§ Kanalisation v. Fr. am Main. Lindley, chief engineer. Druck v. C. Adelmann, Frankfort. 1877..

(2.) In the two districts in great part sewered, 32.0.
(3.) In the four suburban districts not sewered, 46.0.

Dr de Meyer objects that this period is too short to give reliable data, and this would be a serious objection were the case exceptional; but the same thing has been observed in many other localities during much longer periods.

The sewers of Hamburg are forty miles in extent, and are very complete. Large quantities of water are sent through them daily.* The system was designed and built by Mr. Lindley, who followed directions laid down by Edwin Chadwick, the eminent English sanitarian.

According to Dr. de Meyer, the Hamburg sewerage system was begun in 1845 and completed, so far as relates to the old town, in 1853. The sewering of the newer portions of the city continued up to the year 1874. I have not been able to procure mortuary or census data from Hamburg for the years prior to 1872, but, according to Virchow, out of every 1,000 deaths in Hamburg before the introduction of sewerage 48.5 were from typhoid fever; after the city was sewered the typhoid fever deaths were only 13.3 per 1,000 deaths. During the last ten years the typhoid fever mortality in Hamburg has averaged only 3.1 per 10,000 living, and for the last quinquennium only 2.6.

The diminution of the typhoid fever death-rate at Dantzic has been still more remarkable. According to Dr. O. de Meyer† before the introduction of the English system at Dantzic the greater part of the inhabitants deposited their fecal matters in vaults in the interior of the houses. These vaults had plank walls, and when full they were cover d with earth and new vaults were opened. A more abominable system could scarcely be invented or imagined. We are not surprised to find that the typhoid fever death rate in Dantzic under such conditions was never much lower in any year than ten in each 10,000 persons living.

The city was supplied with water in 1869, and sewered in 1872. The rapidity and completeness with which these public works were executed makes Dantzic an especially good city for the study of the influence of sewerage and water-supply on the death-rate. The statistics used in this paper were prepared in great part by Dr. Liévin, with the greatest care, and may be relied on as unquestionably correct; they refer solely to the city inside of the fortifications which is the only part sewered all at once. The water-supply in 1869 does not appear to have produced any marked effect on the typhoid death-rate, but there was a marked drop after the introduction of the sewers in 1872, the average of the twelve years 1873–84 being only 2.4 per 10,000 living, or less than one-fourth of the mean mortality of the ten years prior to this period. The typhoid fever mortality of the last quinquennium has been still lower, being only 1.5 per 10,000.

The English system of sewerage was begun in Breslau in the fall of 1878, and was completed in 1881. Prior to this time the greater part of the houses had privy-pits. The filth from these pits oozed into the soil, and in the so-called sewered portions of the city the in ected soil-water found its way into the cellars of the houses during a large part of the year. The mouths of the old sewers emitted a great stench, and the water of the river Oder was infected for some distance down stream.‡ The influence of the old drains or sewers was, however, on the whole beneficial rather than injurious, as is shown by the marked decline in the typhoid mortality from 1872 on. Dr. Neefe has kindly sent me a table

*Pneumatic Sewerage. Dr. Zehfuss. Pam. pg. 29.
† *Les Systemes d'evacuation des eaux et Immondices d'une ville.* Paris, 1883, pg. 45.
‡ Dr. O. de Meyer, 1883, *loco. cit.*, pp. 42–43.

showing by years the number of houses connected with the sewers and the number of water-closets in use in Breslau. The number of houses connected with the sewers in 1875 was 2,170; in 1884, 5,58:. The number of hundred water-closets in use each year from 187. to 884 was, in round numbers, as follows: 6, 13, 21, 22, 33, 52, 78, 114, 156, 183, 211, 239, 262 and 286. The typhoid fever mortality in Breslau in 1871 was 7.9 per 10,000 living; in 1884 it was 3.1; in 1882 it was as low as 2.8. At no time during this period was it higher than in 1871, and after the year 1872 the highest rate reached was 5.5 per 10,000 in 1876, as against 15.2 in 1866, when there were no water-closets and when there was nothing worthy the name of a sewer system! What do our anti-sewer friends, who can see nothing but disease and danger in water-carriage and water-closets say to this? What becomes of the infection of all the houses with deadly "sewer-gas," the specter of Russell, Fergus, Winterhalter, *et al.?* If the data from Breslau is not convincing, more may be had. That from Frankfort, for instance, where the typhoid fever mortality has decreased *pari passu* with the increase of the "deadly" water-closets!

The number of water-closets in use in Frankfort, with the typhoid mortality of corresponding years, is as follows:

Years.	No. of Closets.	Deaths.	Years.	No. of Closets.	Deaths Per 10,000 Living.
1870	49	5.9	1878	18,151	1.8
1871	400	5.9	1879	19,931	2.2
1872	1,926	6.1	1880*	.....	2.0
1873	4,085	6.5	1881	.....	1.2
1874	7,077	11.3	1882	.....	1.6
1875	11,054	4.2	1883	.....	0.9
1876	13,691	3.3	1884	.....	1.2
1877	16,048	1.3			

Three unsewered German cities, Leipzic, Dresden, and Stuttgart have attained good results from a very carefully managed conservancy system. Some data concerning these cities may be found in connection with the charts and tables at the close of this paper. A comparison of seven German cities in which the utmost attention is paid to the disposal of the night soil (five of them having sewers, and the other two cemented vaults often cleaned) with twenty of the smaller German cities which are either entirely unsewered or but imperfectly supplied with sewers and water-mains, is especially instructive. In the year 1882 the typhoid fever mortality was over three times as great in the latter as in the former (see Table XXVI).

According to Bayles,† "Vienna has reduced its general mortality over

* The exact number added since 1879 is not known, but must be considerable.

† The necessity of using the utmost care in selecting a site for a general water-supply has received additional emphasis from two recent outbreaks of typhoid fever, traced to the fouling of the general water-supply by typhoid excreta. Both occurred in this country and are so well authenticated and so much to the point that I cannot omit brief mention:

1. Outbreak at Sioux Falls, Da. Ty.—The city of Sioux Falls, Da. Ty., obtains its drinking water in part from wells, in part from a system of water-mains lately built by a private corporation and not yet in general use. Typhoid fever was never prevalent to any great extent until last winter (1884-5), when during the months of January and February over 129 cases suddenly appeared. These cases were carefully studied by Dr. S. A. Brown,* a resident physician. All but nine cases were in

* Sanitary science as applied to the Public Health of Sioux Falls. By S. A. Brown, M. D., Humboldt Club, Sioux Falls, D. T.

thirty per cent by the provision of an over-abundant water-supply from the mountains flushing the house-drains and sewers, and supplying pure water in excess of all wants."* Whether this be true or not typhoid fever has wonderfully diminished in recent years. The mean typhoid mortality of Vienna during the last ten years was as follows: In 1880–84, 2.1, in 1875–79, 4.6, per 10,000 living. In the preceding nine years the mean was 11.4 per 10,000.

The sewer system of the city of Brussels is modeled after the English pattern. It was begun in 1868 and completed in 1872. All the excreta have gone into the sewers for the last ten years. No increase of typhoid fever has been noted dur-

persons who lived, worked, or often visited where the general water-supply was used, and who presumably all drank of it. No case of this fever could be traced unmistakably to persons who drank only well water. The disease was especially prevalent in the hotels where the company's water was used exclusively. It may be noted, also, as of interest in this connection, that prior to this outbreak in November and December a severe diarrhea called "winter cholera" had been very prevalent in the hotels and elsewhere, and had excited general comment. This also appeared to be caused or made worse by use of the hydrant water. The indications pointed so unmistakably to the hydrant water as the source of the fever that there was great excitement in the city and a general investigation, during which the following facts were brought out: The first case of the epidemic occurred about January 1; two weeks prior to this, December 18, a case of typhoid fever occurred at the Commercial House, the patient remaining there one week, the bowel discharges being thrown into the hotel sewer which empties into the river. The water company had advertised to furnish water from an inexhaustible and pure spring on their premises, but for some reason they found it more convenient to pump river water into the mains. This was done throughout the winter unknown to the citizens, a secret intake having been put out into the river on the same side as the Commercial House and only a few yards below the mouth of its sewer. Here, then, was the explanation of the mystery. The undisinfected typhoid discharges passed from the hotel sewer into the river and were thence pumped into the water mains and distributed to the citizens. After the usual incubation period the disease developed rapidly, and ceased as suddenly when the hydrant water was shut off, the last case occurring just four weeks later. It is perhaps unnecessary to add that one water company at least have learned a lesson not soon to be forgotten. It appears to me, however, that there are a good many wooden-headed water commissioners in other cities who might take this lesson to heart. The stupidity of drawing a general water-supply from the heart of a city, either directly from a river or from shallow wells or springs, is only equaled by that of placing the choice of so important a matter as water for a whole city in the hands of men who know no better.

2. OUTBREAK AT PLYMOUTH, PA.—An alarming epidemic of typhoid fever occurred at Plymouth, Pa., in the spring of 1885. The disease appeared so suddenly, and was so wide-spread and fatal, that it excited general comment throughout the United States. From the conflicting accounts which were first given to the press it seemed that the dreaded Asiatic cholera might indeed be among us. The city of Plymouth contains a population of about 8,000. In this small community within a period of a few weeks there were more than 1,000 cases and 100 deaths from typhoid fever. The epidemic was studied on the spot by competent New York and Pennsylvania physicians, so that no doubt is left either as to the nature of the disease or as to the method of its introduction and spread. (*Report upon the Epidemic of Typhoid Fever at Plymouth, Pa.* By Lewis H. Taylor, M. D., of Wilkes-Barre, Pa.) This outbreak offers one of the most notable examples in all sanitary literature of the possibility of infecting the water-supply of a whole city by the poison from a single sick person, and incidentally shows the futility of chemical analysis to determine positively whether a drinking water will cause disease, since an analysis of the hydrant water by a very competent chemist, Dr. R. C. Kedzie, of the Michigan Agricultural College, showed it to be comparatively pure, while that from the shallow wells used by many of the citizens, and to which no fever could be traced, was steeped in organic matters, and, to quote Dr. Kedzie's expressive phrase, was "more fit for the dung-hill than the dinner-pot." The facts, sifted and tested by rigid and expert scientific methods, are as follows:

The general water-supply of Plymouth is obtained from a mountain brook, a number of dams being thrown across the stream for this purpose. During part of the winter of 1884–5, owing to the deep freezing of this stream, the hydrant water was taken from the neighboring river, Susquehanna. There are very few houses on the banks of the mountain brook, and it would seem that the stream is unusually well protected from sources of contamination. During the time that the stream was frozen a man came from Philadelphia sick of typhoid fever. He had contracted the disease at a place from which three other persons, sick with fever, had been removed to the hospital. This man was cared for in a house near the source of this mountain stream, or at least considerably above where the city water-supply was procured. The discharges from the bowels of this sick man were not disinfected. They were thrown by the nurse on the deep snow of a sidehill sloping toward the stream which was not over forty feet distant. A sudden rise in the temperature toward the close of March caused a general thaw, and the melted snow of the hillside with its mass of typhoid poison was swept into the stream. At just this time, owing to the rise of the water in the brook, the Susquehanna river water was shut off from the water-mains, and that of the brook turned on again. In this way the typhoid poison was pumped to all parts of the city. In about two or three weeks hundreds of cases of fever developed, and these were confined exclusively to persons who used the hydrant water. No cases were traceable to well water except much later, and by secondary infection. Whole groups of families using well water or river water exclusively escaped entirely. In parts of the city where the use of well water was the rule and the use of hydrant water the exception, only those families suffered which used the latter. One notable instance is mentioned by Dr. Taylor where in the upper end of the city one family only suffered from the disease. It was supposed at first that all in that vicinity used well water, but further inquiry showed this one family to have been in the habit of catching and using the hydrant water which leaked from the main aqueduct on its way down into the city, preferring the pure water of the mountain stream to that of the foul wells of the neighborhood. Such cases are, of course, no argument in favor of a return to the use of well water, but only one for greater care to prevent accidental contamination. This outbreak speaks volumes in favor of the specific nature of the typhoid fever poison.

* House Drainage and Water Service. By Jas. C. Bayles. N. Y., 1878, pg. 43. This footnote should have been printed on the page opposite this in place of the * footnote which should have been printed where this stands.

ing this decade, but on the contrary there has been a marked decrease, and when the entire city is as carefully sewered and supplied with water as London or New York, the typhoid mortality will undoubtedly be as low. The average rate for the last ten years has been 3.6 per 10,000 living, which is a good showing when compared with the 9.3 of the preceding decade.

The typhoid fever mortality in Stockholm has gradually decreased in recent years (see table), "doubtless," according to Dr Linroth (*loco citat.*, p. 17 of Appendix I), "in consequence of the extension of sewers and of water-works and the improvement of dwelling houses," and of streets and alleys in the older parts of the city.

At the close of the year 1884 Stockholm had necessaries, with tubs or water-closets, to the number of 49,275, of which 38,381 were outside of the dwellings, and 10,894 inside. Of these necessaries 13,124 were apparently water-closets proper, connected with the sewers, and 35,600 of the remaining number were tubs, cleaned at stated intervals in the night by excavating companies. The city is not completely sewered.

A similar reduction of typhoid fever is said by Dr. de Pietra Santa and others to have followed the introduction of sewers at Zurich, Geneva, Lausanne and elsewhere on the continent.

Turning now to England where, perhaps, more than in any other country, the principles of sanitary science have been studied and applied during the last thirty years, we find a marked diminution of the fever death-rate in recent years. The influence of the Public Health Act of 1872 was very perceptible, and again three years later, in 1875, when a more rigid public health act went into operation, there was another perceptible drop in the fever mortality. These two acts, among other provisions, laid great stress on the careful disposal of excreta, and were so framed that the execution of their provisions was not only possible but practicable, so that these were thoroughly enforced in very many places throughout the kingdom. The effect of these acts will be apparent from an examination of the statistics. From 1876 to 1884 the English fever death-rate is only 3.6 per year, while the mean annual fever mortality prior to 1872 (1850–71) is 9.0 per 10,000 living.

In some places in England, as at Croydon, Westminster,* etc., typhoid fever increased after the sewering of towns, owing to want of sewer ventilation, loose joints, or other imperfections in the system, but these instances are quite exceptional. The total English death-rate from typhoid has greatly diminished in recent years, and this is particularly true of the best sewered districts.† Even those which are imperfectly sewered seem, both in England and on the continent, to have a better chance of escaping cholera and typhoid fever than the unsewered towns.

In London, prior to 1815, to quote Krepp:‡

"Cesspools were looked upon as the proper receptacles for excrements, and sewers only as channels for surface water. The latter were at first open gutters, and only afterwards closed to gain more room in the streets. Up to 1815 it was penal to throw any excremental or any other offensive matter into them.

"These cesspits were built of brick or stone, often without mortar, leaving the walls quite porous, and hence they seldom overflowed, the liquids percolating continually into the ground. In course of time, as the population increased, the subsoil became studded with these barbarous contrivances.

* *Health and Sewage of Towns*, Society for the Encouragement of Arts, Manufacturers and Commerce, London, 1878, p. 51; *The Study of Sociology*, Herbert Spencer. Int. Sci. Series, Vol. V, Chap. I, and note in Appendix. New York: D. Appleton & Co., 1882.

† *Sanitary Engineering*. Baldwin Latham, London. Latham's Statistics, giving mortality from typhoid, consumption, etc., in twelve English cities before and after sewerage, are interesting, but are so well known and have been quoted so often that it has not been thought necessary to include them.

‡ *The Sewage Question*. Krepp. London, 1867, pp. 12, 13.

When improved closet fixtures came into use, and superior cleanly habits caused much water to enter these pits they began to overflow, often thoroughly saturating the whole site with most offensive fluid; it was therefore, from 1815 to 1847, permitted to build overflow drains from the cesspools into the sewers, which by sheer necessity were changed from open streams into covered brick conduits.

"In the year 1847 an act of Parliament made it compulsory to drain all privy contents into the sewers. * * * * * *

"During the six years that this scheme was followed (Metropolitan Com. of Sewers, inst. 1847), over 30,000 cesspools were abolished, the entire filth of London being conducted direct into the Thames."

According to the same author, and other authorities, the drinking water of London in 1849 was notoriously contaminated by cesspools and water-closets, and in many instances by choleraic discharges. London has since been supplied with good water and with a very complete sewerage system. The first portion of the new sewerage works of London was begun in January, 1859. The works on the north side of the Thames were formally opened by the Prince of Wales in April, 1865.*

The fever mortality† of London has fallen off noticeably since 1865, and is to-day only one-fifth as great as in the period prior to 1860.

Coming now to our own side of the Atlantic, we find that comparatively few American cities are thoroughly sewered, or have been so for a period long enough to give useful data. In many cases, also, as stated at the outset, the statistics of population, or of mortality, are themselves untrustworthy, or entirely wanting. Fortunately, however, in a few of our larger sewered cities very accurate census and mortuary records are kept. The data from these cities agree exactly with those of the old world cities already considered.

New York and Brooklyn unquestionably have the best water-supply and general sewerage systems of any of our larger cities. These they have enjoyed for a long series of years, and the effect on the typhoid mortality has been correspondingly marked. The typhoid fever mortality of New York for the last decade has been only 2.8, that of Brooklyn 1.5, and at no time during the last thirty-five years has the annual typhoid mortality of either city exceeded 8.0 deaths per each 10,000 inhabitants, and rarely has it exceeded 4.0 per 10,000.

New York has enjoyed an abundant and pure supply of water since 1842 (more completely distributed, of course, in recent years), and as early as 1858 had over 100 miles of sewers. The magnificent Croton aqueduct, which brings the city water-supply from Croton River, forty miles away, has a capacity of 115,000,000 gallons per day, and a new aqueduct, nearly parallel to the old, is being constructed to bring in an additional supply. The city now has about 300 miles of sewers.

The Brooklyn water-works were begun in 1856 and completed two years later, with a capacity of 40,000,000 gallons daily. The city now has an abundant supply of pure water brought through an elaborate system of reservoirs, the most distant being at Hempstead, nineteen miles away. In 1883‡ there remained in the entire city only 124 wells, of which all but eighteen had been condemned. Brooklyn is the best sewered large city on this continent, and, with the exception of Chicago, was the first city in the United States to undertake a complete system of sewerage. The Sewer Commission was organized in 1856, and plans were soon after drawn up and ground broken. Writing of the

* For an interesting description of these great works see pp. 12 to 28 of Krepp's "The Sewage Question," London, 1867. An excellent brief comparison of the drainage systems of London and Paris may also be found on p. 223 of the third Biennial Report (1874-5) of the State Board of Health of California.

† Includes typhus, typhoid, simple and ill-defined fevers. Typhus and simple and ill-defined fevers in recent years have formed only a small per cent. of the total English fever mortality. For a statement of the fever rate by ten-year periods in all the larger English cities, London included, see chart I.

‡ Annual Report of the Health Department of Brooklyn for 1883.

Brooklyn sewer system in 1876, the eminent engineer, Col. J. W. Adams, says: *

"The yearly discharge from the sewers, including rainfall, equals in volume what would fill the entire streets and avenues of the city to a depth of twelve feet above the pavement, or three feet over every parlor floor in the city. Such is the amount of work silently going on beneath our feet, of which we take no note save when it is interrupted."

Dr. J. C. Hutchison, chairman of the sanitary committee of the Brooklyn Board of Health, estimated the number of houses in Brooklyn in 1874 at 67,000, of which 40,000 had sewer connections, the remaining 27,000 having excavations in the earth for the reception of excreta. Boston, St. Louis, and Chicago are also sewered cities, but the typhoid mortality is not so low as we should expect, and some explanation is necessary. The Boston sewer system till recently has been far from complete, and the typhoid fever mortality is much higher than we may expect it to be in the coming decade, now that the new collectors are built. The introduction of the Boston water-supply dates from October 25, 1848, soon after which, if we may trust the data, there was a marked fall in the typhoid mortality. The sewers of Boston formerly emptied into Charles River, or into the harbor and south bay, and there were many neglected sources of filth in and about the city. In January, 1884,† a great intercepting system was completed and set in operation, and the sewage of Boston is now washed into a powerful current which sweeps it five miles out into the open sea. The water-supply of Chicago is drawn from Lake Michigan, and is probably not seriously contaminated, although it is not above suspicion. The water system was begun in 1858. There is only one well in the city, so stated. The sewer system is extensive and said to be well built. It was begun in 1855 and is being continually added to, but the entire city is not sewered.‡ In certain crowded districts, inhabited chiefly by an ignorant foreign population, living in attics and cellars, there are no sewerage or drainage facilities. Out of 97,000 structures, about 78,000 have sewer connections. I have been unable to learn the number of vaults still in use, but judging from the annual reports of sanitary inspectors it must be large.§ The fluctuations of the Chicago fever mortality have been considerable during the past thirty years. The sewers and water-supply of the city have not been able to keep pace with her astonishingly rapid growth,‖ in spite of the millions spent upon them. Judging from the typhoid mortality, cholera would probably find a congenial home in certain parts of Chicago. What is true of Chicago is also true in a lesser degree of St. Louis, about the sewerage, water-supply, and mortality of which I shall have more to say hereafter.

Turning now to the non-sewered or imperfectly sewered cities we find a very different state of affairs. First, as to Europe, England as before stated may be taken as the best sewered country, next Germany, and then, among the less perfectly sewered countries, France, Italy, Spain, and Russia, in the order named. Studying the subject by groups of cities in these countries, we find the highest typhoid mortality in the least perfectly sewered countries. The mean typhoid mortality of twenty-eight large English cities in the five years, 1880–84, was 3.2 per 10,000 living; that of 173 German cities in the five years, 1878–82, was 4.1; that of thirteen chief Italian cities in the four years, 1881–84, was

* Brooklyn Board of Health Report, 1875-6, p. 166.

† *Sanitary News*, Chicago, May 15, 1884, p. 15.

‡ "Twenty-two miles of sewers were laid in Chicago last year, making about 436 miles now laid in the city." *The Sanitary News*. Chicago, Jan. 9, 1886.

§ The report of the tenement and factory inspectors for the year 1885 shows that 10,960 vaults were cleaned during the year.

‖ The population of Chicago in 1850 was 30,000, in 1884 it was 650,000. It has doubled twice within the last 22 years.

9.3. The average of 281 Italian towns (*comuni capoluoghi*) for the biennium 1881–2 is not far from that of the thirteen largest cities, being 9.5 per 10,000 inhabitants If the data from Spanish and Russian towns were procurable and trustworthy, I am certain, from what I know of the condition of their sewerage and water-supply, that we should find the same high typhoid mortality. Indeed, given the sanitary condition of any town, and we can predict the typhoid death-rate with considerable certainty, or given the latter and we can tell the state of the sewerage and the water-supply. I have so frequently made predictions of this kind which have been verified by data subsequently received, that I do not think there can be any question as to the fact itself. Who will, for instance, for a moment contend that Italy is as well sewered as England or Germany? Certainly no one who is familiar with sanitary literature or who has traveled through Italian towns. Who on the other hand will deny that with its magnificent climate Italy might not become as healthy as any European country? Indeed, the prophecy of all this and more is in the wise government, and the increasing literary and scientific activity of the new Italy!

If we turn from groups of towns to individual cities, we find the highest typhoid fever mortality in those in which the greatest carelessness prevails as to the disposal of the night-soil.

The cities of Rome and Genoa, for example, have an exceptionally good water-supply, and Venice has water-ways for streets. The average typhoid mortality of the last two years, 1883 and 1884, in these cities has been respectively 4.7, 5.2, and 4.9 per 10,000 inhabitants. The defective water-supply and the general insanitary condition of Palermo and of Turin, on the contrary, are notorious, and their average typhoid mortality during the same period was respectively 12.0, and 8.0 per 10,000 inhabitants, and lest it be thought that these were exceptional years it may be added that the mean typhoid mortality of the last four years (1881–4) in Palermo is 13.1, and of the last twenty-five years in Turin is 11.0 per 10,000 living. The mortality from typhoid fever is still higher in some of the other Italian towns. In the old town of Catania, situated in the granary of Sicily, and styled "*La Belle Catania*," from its fertile soil, fine scenery, and delightful climate, the mean typhoid mortality has been 17.8 for the past four years, and the mortality of earlier years was even greater (see Table XVII). The recent high rate in a number of the smaller German cities has been already alluded to.

The typhoid fever mortality of Moscow and of St. Petersburg is very great. That of the latter city was 10.6 per 10,000 living in 1883, and 9.3 in 1884. Neither city is sewered, in any proper sense of the term

Buda Pesth is a dirty city with a population of 400,000. Until recently it was very imperfectly sewered, and the typhoid death-rate was correspondingly high, the average for the nine years, 1874–81, being 10.0 per each 10,000 living. (See Table XXVIII., and also Dr Fodor's statistics given further on.) Under the active direction of Dr. Körösi and his coadjutors the sanitary condition of the city has been greatly improved in recent years, with marked decrease of typhoid fever and other diseases.

Among French cities we naturally turn first to Paris. Paris must be classed with the imperfectly sewered cities, for although the city has an elaborate and costly system of drainage, it is not *well sewered*. Beyond simple drainage, it derives little benefit, in a sanitary way, from its great sewers because, owing to their size and defective gradients, excreta have not been and can never be allowed to enter many of them. The main use of the elaborate and expensive system is to

carry off the rain-fall and the house and street slops. The night-soil is provided for in various ways. Much of it goes into vaults, which are emptied from time to time. Many of these vaults are built under houses in the earth, or in cellars, and are a great nuisance. Recently sewage of all sorts has been allowed to enter a few of the Paris sewers without the bad results which it was predicted would surely follow. Durand-Claye* found that the sewers of Paris had a favorable influence on typhoid, and MM. Vallin and Hudelo† have found no reason for believing that the Paris sewers have any causative relation whatever to typhoid fever. In the matter of sewage disposal there is a striking contrast between London and Paris. The London sewers are comparatively small and always foul, but the city is clean. In Paris the reverse is true. The sewers are roomy and very clean. There is a central gutter, along either side of which one can walk dry-shod, while over head are water-pipes, air-tubes, telegraph and telephone wires, etc., bolted into the solid masonry. Admiring tourists often visit the Paris sewers, and, seeing their clean condition, bring away the impression that Paris is the best sewered city in the world. This, however, is far from true. Except in the finer quarters, Paris is very ill-sewered and dirty, judged by an American or English standard. Such, at least, is the report of those who have visited the city and made personal inspection. The plumbing arrangements in particular are extremely crude and defective. Devices which we abandoned years ago are still in general use. Sewer and cesspit air is said to have free access to a majority of the houses, and there appears to be a dearth of good plumbers. The bad condition of the plumbing arrangements in Paris was thus described by Adolphus Smith, of London, at the Geneva Congress in 1882:‡

"In France at Paris the sewers are not ventilated; they have no intercepting traps, indeed no traps at all. The houses are lungs, the soil pipes are bronchi, which on account of position and difference of temperature, suck up miasms and bacteria to send them into the rooms, and thence out of the windows."

In the year 1882 Paris had no less than 80,000 cesspits§ and 30,000 shallow wells‖, most of the latter having been shown by repeated analyses to be badly contaminated and entirely unfit for use. The recent investigations of M. Durand-Claye have not indicated any close relation between the Paris typhoid and the general water-supply of the city, although the water of the canal L'Ourcq is not beyond suspicion, and in earlier times was unquestionably contaminated. Such a condition of things is favorable to the spread of typhoid fever, and we should expect *a priori* to find it very prevalent in Paris, or, at least, much more frequent than in London and other cities where plumbing has been reduced to a fine art, and where vaults and shallow wells have been abandoned. Such is the case. Typhoid fever is never absent from Paris, dreadful epidemics have repeatedly visited the more crowded and dirty quarters, and the disease has increased rather than diminished in recent years.¶ The typhoid fever mortality in Paris during the decade 1865–75 was as high as 7.9 per 10,000 inhabitants, and during the last decade, 1875–1884, was 8.5. The total deaths from typhoid fever in Paris during these twenty years were more than 33,000, and this, too, in

* *Loco citat.*
† *Revue d' Hygiène*, Apr. 20, 1885.
‡ See also an editorial in London Lancet, January 6, 1883, pg. 31. The Lancet warns English tourists to avoid Paris.
§ Dr. O. de Meyer, 1883, *loco cit.*, pp. 6, 15.
‖ *L'Assainissement de Paris*, etc. Wazon. Paris, 1884.
¶ "*Depuis plusieurs années cette terrible maladie domine, dans la capitale de la France, une mortalité spéciale, triple ou quadruple de celle qu'on constate dans plusieurs grandes villes, telles que London, Bruxelles et même Berlin.*" *L'Epidémie de Fièvre Typhoïde à Paris en* 1882. Par M. A. Durand-Claye, Paris, 1883. An elaborate and interesting study of the great epidemic.

a city admirably located and capable of becoming one of the healthiest as it now is one of the finest on the globe.*

The sanitary condition of certain other French cities is vastly worse than that of Paris. Toulon, in Mediterranean France, is an example. This city has been a plague-spot from time immemorial. No epidemic of plague, of typhus, or of cholera has ever omitted Toulon. Worst of all, no epidemic appears able to teach its citizens any sanitary lesson. As soon as the danger is gone they relapse into their normal state of nastiness and inertia It would be wisdom for the civilized world to buy up and destroy this city, root and branch, rather than suffer it to remain a breeding ground and centre of infection in each successive epidemic of cholera. The city has no sewer system, the water-supply is defective, the houses are crowded, the population is ignorant, and in the worst quarters of the city the nastiness beggars description. To quote Dr. Peters :†

"In the lower part of Toulon the water-supply is scanty and bad, and much runs from the fountains in the upper part into the gutters in the lower part and down to the harbor, which is land-locked, almost tideless, and so very foul that typhoid fever prevails largely at almost all times. The lower Toulonese also have no privies, but empty their chamber pots into the streets and gutters every morning, and throw all their garbage there also. The market people were seen (1884) freshening their vegetables by dipping them in the gutter water."

As might be supposed from the character of the place no trustworthy mortuary records are available, and so we pass to the consideration of the neighboring city of Marseilles, which is larger and somewhat cleaner than Toulon, but like it has been visited repeatedly by pestilence—typhus, typhoid, cholera, and yellow fever. The Department of State has recently published a Consular Report‡ in which it is stated that Marseilles is in a good sanitary condition. To quote:

"Her pavements, her sewerage system, her water-supply and method of cleaning streets, removing night-soil, inspecting and regulating the food market, her quarantine regulations and hospital facilities are all probably unsurpassed in excellence by those of any European or American city."

I am persuaded that our consul must have received his information entirely at second hand, and from merchants or other interested parties. I cannot otherwise understand why he should write such nonsense. The insanitary condition of Marseilles is notorious, and was the very thing which invited the cholera in 1884. There are great numbers of vaults in bad condition, and shallow wells to which cholera and fever have been repeatedly traced. Many of the drains are old and all of them defective,—mere sinks of corruption. Speaking of the sanitary condition of Marseilles, Dr. Albenois, the well-informed health officer of the city, under date of June 3, 1884, writes:

"Cholera has almost exclusively prevailed in the quarters *destitute of sewers*. We are poorly provided in Marseilles with sewers. They are to be found only in the avenues. The older parts of the city are absolutely destitute of them, and they are all so badly built that they need to be completely re-built.

"Out of a total of about 32,000 houses in Marseilles, about 10,000 have porous-walled cesspits (*éponges ou puisards*), but the system of water supply and of the disposal of night-soil is as primitive as possible. No precautions are taken, and the houses communicate freely with the sewers (drains), and the latter by infiltrations with the wells."

The typhoid fever mortality at Marseilles for the past quinquennium, 1880–84, was 12.8 per 10,000 inhabitants. The records prior to 1880 are imperfect.

* "Nothing could be easier than the drainage of Paris. The area of the city is small and the gradien is so good, that the system might be made the most perfect and the Paris atmosphere the purest of any city in the world." *Edwin Chadwick in conversation with Napoleon III. at the Paris Exposition in 1854. The Sanitarian*, vol. 5, p. 181, New York.

† Treatise on Asiatic Cholera. Wendt. Wood's Library of Standard Medical Authors, New York. Wm. Wood & Co. 1885.

‡ Cholera in Europe in 1884, pages 103. Washington. Government Printing Office, 1885.

In the European armies, composed of young and middle aged men, the typhoid fever mortality is, of course, much greater than in the civil populations made up of persons at all ages. I borrow the following interesting data from Rochard:*

MEAN DEATH-RATE FROM TYPHOID FEVER IN THE STANDING ARMIES OF EUROPE, PER EACH 10,000 MEN.

France	33.7
Italy	20.9
Austria	15.8
Prussia	9.5
England	3.1

It will thus be seen that on an average, exclusive of the English army, there are twenty deaths per year to each 10,000 soldiers.

In the United States, in addition to the cities already mentioned, I have studied the sanitary condition and the death-rate of Baltimore, Cincinnati, St. Louis, and New Orleans, which I will consider briefly, seriatim:

Baltimore is a city of 360,000 inhabitants, situated on an undulating district possessing good natural drainage. The sewerage system is partial and imperfect, and was designed to carry off rain and surface water only. The greater part of the city depends entirely upon surface-drainage. It is estimated that there are 70,000 or 80,000 open privies in the city, and that one-twentieth of the entire surface, exclusive of streets and parks, is occupied by them.†

The night-soil is removed from the privy-pits by odorless excavating machines into water-tight tanks or barrels. These receptacles are carried to two dumping stations at the water's edge, and the excreta is thence transported in tight barges and dumped fourteen miles from the city. In a letter dated May 30, 1885, in reference to the water-supply, Dr. James A. Steuart, the Commissioner of Health, says:

"There has been no change in the *mode* of water-supply for this city since 1880, but about that time a very great addition was made by the introduction of the Gunpowder river supply which is brought to the city, or rather to two great storage tanks near the city, through a tunnel twelve feet in diameter and seven miles in length, at a cost of $4,000,000. This with the Jones-falls supply gives daily a supply in abundance for more than 1,000,000 people. All the water thus introduced is exceptionally pure and good."

The number of wells in use is not stated. We have mortuary data from Baltimore since 1860. There appears to have been considerable decrease in the typhoid mortality since 1881, which is perhaps due to the increased water-supply. The typhoid death-rate is, however, much too high, the mean rate per 10,000 living having been during the last five quinquennia, as follows: 7.4; 7.8; 8.0; 6.1; and 4.8. The city needs a well devised and carefully built system of sewers. With such a system the yearly typhoid mortality could certainly be reduced to one or two in 10,000.

In 1880 Cincinnati had a population of 255,000. Apparently only about one-third or one-fourth of the city is provided with sewers, new and old.‡ The excreta go chiefly into privy-pits, and most of the water-closets drain into vaults, instead of into the sewers.§ Dry earth closets are rare. In a valuable

* *La Valeur Économique de la vie humaine, et sa comptabilité.* Par M. Jules Rochard, pp. 62-96 of Tome I. of *Comptes Rendus et Mémoires du Vme Cong. International d'Hygiène et de démographie, à La Haye.* The Hague, Aug., 1884, p. 83.

† Report of St. Bd. of H. of Md., 1880, pp. 15 and 19; "Local Causes of Insanitation in Baltimore": Report of St. Bd. of H. of Md., 1878, pp. 87-109.

‡ See map of sewers, etc., in "*The Fourteenth Annual Report of the Health Department.*" Year, 1880.

§ Thirteenth Annual Report of the Health Department, 1879.

report made to the health officer, December 31, 1880, Mr. H. J. Stanley, the Chief Engineer of the Board of Public Works, says:

"Cincinnati can hardly say she has a system of sewerage. Not a ward can boast of perfect drainage facilities. Our sewers, so far as completed, are good,—in some cases excellent.

"The imperfect drainage does not arise from defective construction, but from the absence of sewers. The demand for them has been for convenience, and not for sanitary uses. Plans for sewering nearly the entire city are on file in this office, but owing to lack of funds and opposition from property owners they have not been projected. The total length of existing sewers is 47.388 miles; these furnish 20,000 available house connections, of which 2,976 are used."

The sewers empty into the Ohio river. The vaults are emptied whenever their contents are found within four feet of the surface of the ground. The night-soil is hauled at night in carts to a dumping boat on the Ohio, in which it is transported down stream and emptied into the river. Cisterns are tightly cemented and there are few wells in use. The health officer, C. W. Rowland, says that not more than one per cent. of the inhabitants use well water. He does not think any cases of typhoid can be traced to the water supply—"none clearly so, at least."

The mean typhoid mortality is about the same as that of Baltimore, but it has been higher in recent years than formerly, the mean of each of four consecutive five-year periods being 7.6, 5.9, 5.8 and 7.3 for each 10,000 inhabitants. This is much too high, and the remedy is apparent. Householders should be compelled to connect their property with the general sewer system, and all vaults should be cleaned and abandoned.

St. Louis has a sewer system and a general water-supply, but many houses are not connected with either. It is said that there are still in use about 30,000 privies and also about 8,000 surface wells. The wells of the city are nearly all contaminated by fecal matters, and fever and cholera have frequently been traced to them. Many bad wells have been condemned by the health authorities and abolished; often, however, against strong opposition on the part of the householders, the police being this year mobbed while carrying out the orders of the Commissioner of Health. The total miles of sewers at the close of 1884 was 223, and of water-pipes was 238. The consumption of water during the year averaged 27,400,000 gallons per day. The population of the city is 400,000.

There has been a marked decrease of typhoid deaths in St. Louis in recent years, and if the present vigorous sanitary measures are continued the city will soon be on a level with the best sewered cities as regards immunity from typhoid fever. The mean typhoid mortality per 10,000 living for each of the past four quinquennia has been 10.4, 7.2, 3.5 and 4.3.

The city of New Orleans has a population of 220,000, and covers an area of fifty-five square miles. The Mississippi River flows in front and Lake Ponchartrain lies at the rear. The surface of the city slopes back gently from the river one mile, where the surface is twelve feet below the Mississippi.

The entire city is below high water mark of both the river and the lake, and is surrounded by *levees*. There are 26,026 acres inside the *levees*. The city has no underground sewers and no natural facilities for drainage.* The soil is always saturated with moisture. In lieu of sewers there are 300 miles of stinking gutters, and thirty-five miles of large open drainage canals, which slowly

* "In the city of New Orleans, bounded by the Mississippi River, which has truly been compared to an inland sea, on the one side, and on the other by extended marshes, lakes, swamps, and lagoons, and in high water lying far below the line of the surrounding waters, the questions of drainage, sewage and sanitation have been of the most difficult and complicated character."—*Joseph Jones, M. D., in Report of La. St. Bd. of H.*, 1881, *pg.* 231.

drain away a portion of the city's filth into the cypress swamp at the rear. The excreta go into privy pits of which there are about 40,000. These are cleaned at intervals, but are far from being scrupulously well kept.

The city water-supply is drawn almost exclusively from the Mississippi or from cisterns *built above ground*. There are some wells, but the citizens very generally avoid them, from a belief that the water is unwholesome. The site of New Orleans is very unfavorable, but owing, perhaps, to the active work of the State Board of Health and of the New Orleans Auxiliary Sanitary Association, fostered by the liberality of her citizens, the death-rate has been much reduced in recent years, and will now compare very favorably with that of Berlin, Vienna, and some other great European capitals. It is still, however, much above that enjoyed by dry, well-watered, well-sewered, and clean cities such as Brooklyn, New York, or London.

The immunity from typhoid fever in recent years (see Table X.) must be attributed in part, at least, to the almost exclusive use of rainwater for cooking and drinking purposes; Dr S. S. Herrick, Secretary of the Louisiana Board of Health thinks, also, to the absence of underground sewers; but I am inclined to question this My own conclusions as to the influence of sewerage on typhoid and diphtheria are very different from those reached by Dr. Herrick in his paper, "The Relation between Underground Sewerage and Filth Diseases," read before the American Public Health Association at St. Louis in 1884. Unfortunately I have not seen his statistical tables, but only a summary of the paper, published in the *Sanitarian*, November, 1884. Dr. Herrick used data of three years only (1880, '81, and '82), a period much too short to secure correct results. If his data are drawn from American cities there might easily be several other grave sources of error,—one of the most considerable of which would be incomplete mortuary records.

Cholera and yellow fever have always found a congenial home in New Orleans, and will undoubtedly continue to do so until the entire city is well sewered. It would be very interesting to compare the typhoid mortality of New Orleans with that of the State at large, but there are no statistics.

According to Dr. Wm. Oldright, ex-President of the Provincial Board of Health of Ontario, the three Canadian cities of Hamilton, London, and Toronto have only partial sewerage and water-supply. The contents of many privy-pits pollute the soil and drinking water; refuse is deposited in ravines and hollows; there is no skilled inspection of house drainage, and the sewers now in use do not carry the sewage to a safe distance, nor dispose of it properly. In these three cities the typhoid mortality is high, the mean of three years in London, 1882–4, being 7.6 per 10,000 inhabitants, and of four years in Toronto, 1881–4, being 7.2. The rate in Hamilton is somewhat lower.

Certain other American cities would give more striking figures than those I have selected, could data be procured,—the city of Mexico for example. This city has a population of 250,000, and is destitute of sewers. The water supply of 44 gallons per day per individual is said to be good. The fever mortality is very high, although the climate is all that could be desired. Other Mexican cities are in even worse sanitary condition. The city of Guayaquil in Ecuador has a population of 30,000. It enjoys a fine climate and there are ample facilities for drainage, but there are no sewers and no water closets. The solid filth of the city is received into tubs and thrown into the river; the liquid filth is thrown into the streets. The chief diseases are fevers and dysentery. The

mortality of children is very great. The annual death-rate is over 120 per 1,000.*

The statistics cited in this paper, together with many others not mentioned, show clearly enough that the marked decrease of typhoid fever in sewered cities in recent years must be attributed to the influence of the sewers and the attendant water-supply, rather than to any unknown telluric influence at work the world over. There is, however, in localities where the soil has become foul, an autumnal exacerbation of the disease, which appears to depend on high temperature and deficient soil-moisture. A study of the tables appended will also show a slight rise and fall of the typhoid death-rate at intervals of about ten years, which is also probably telluric in origin. Both movements are least noticeable in well-sewered cities. If we may take the death-rate as indicative of the amount of sickness, one of these long range movements of increased typhoid prevalence passed over this country in 1870–2, and another about ten years later, 1881–2. So far as I can learn from published observations and from records furnished me by the United States Signal office, both these periods were characterized by unusually high temperature and by decreased rain-fall over large areas of the Eastern and Central United States, and presumably, also, by unusually low ground-water. I was curious to know if this increase of typhoid in 1870–2, and again in 1881–2, was general in the Eastern United States, and for this purpose examined the records of a number of cities not included in my tables. In each case I found a slight increase of mortality in these years. If there be any connection between high temperature, low ground-water and typhoid, we might expect to find some long-range fluctuations of this sort, which would, of course, be greatest in those cities where the drouth and high temperature were most prolonged.

In Charts I. and II. I have grouped certain typhoid fever data into graphic form for easy reference. With reference to Chart II., it has been suggested that it is unfair to compare the cities of the first group with those of the second group, since they are differently situated as regards soil, climate, latitude, etc. I am inclined to think this objection is without much weight, since the typhoid mortality in the cities of Group I. was formerly as high as it now is in Group II. (See tables and Chart I.)

ASIATIC CHOLERA.

The ever-present typhoid fever causes more deaths in Europe and America than do the occasional visitations of cholera, and therefore the former deserves more careful attention. The swift and wide-spread destructiveness, however, of cholera during its brief visits to the north temperate zone renders it a peculiarly terrible disease. Its approach always leads to panic, and well it may, since it has been known to depopulate whole villages in its desolating march. Cholera is unquestionably a "germ disease," although this has not yet been experimentally established. The infective material of cholera is derived from the bowel discharges, and is taken into the human system through the air we breathe, the food we eat or the fluids we drink. It spreads, therefore, in a manner similar to the typhoid poison. This proposition is so well established that no time need be spent in adducing proofs. We may, however, study with profit the peculiar conditions of soil, air and water which always precede any extended epidemic of cholera.

* H. N. Beach, U. S. Consul, in *The Sanitary News*, Chicago, Dec. 15, 1883, p. 53. During the study of this subject I have come across considerable data going to show that diseases of children and diarrheal diseases of all sorts have diminished materially in the best sewered cities subsequent to the introduction of the sewers, but the time at my disposal has prevented any extended consideration of other diseases than the three first chosen.

Cholera having ravaged Italy and France in 1884, and being now fearfully prevalent in Mediterranean Spain, with prospect of spread to other parts of Europe and to America, a study of this sort is now of special interest.

Before proceeding to consider the relations of cholera to sewers and water supply in general, let us trace briefly the movements of this present epidemic, first laying down the following general propositions:

In Cholera Epidemics:

(*1.*) *Unsewered cities suffer severely; sewered cities escape, or suffer chiefly in the unsewered districts;*

(*2.*) *A pure and abundant water supply is a great safeguard;*

(*3.*) *Cesspools, privy pits and stagnant drains are sources of great danger;*

(*4.*) *Localities subject to typhoid fever are the ones likely to be visited by cholera;*

(*5.*) *The cholera-scourged cities of one epidemic are usually those of the next epidemic unless, meantime, there has been marked sanitary improvement.*

India, with its dank jungles and water-logged river bottoms, is the home of cholera. Its tropical rains and tropical sun beating on a soil saturated with the filth of teeming millions during untold generations produce a condition favorable to the permanent maintenance of this pestilence. Portions of India are never free from cholera, i. e., the disease is there *endemic*. Every now and then it becomes *epidemic*, and overstepping all bounds spreads northeastward into China and Japan, and westward into Europe, Africa, and America. One of these devastating cholera epidemics reached lower Egypt in 1883, breaking out with alarming violence at Damietta, and gradually extending over the whole Nile delta. It need scarcely be said that cholera found a congenial soil and developed rapidly in the dirty cities of lower Egypt. The local conditions favoring an outbreak were thus graphically described by Drs Chaffey-Bey and Ferrari in a report to his excellency Hassan-Pacha-Mahmoud on the Cholera at Damietta:*

"Damietta is a typical filthy city. It is situated on the east bank of the Nile, thirteen miles from its mouth. The soil is the ordinary Nile alluvion. At this point the river makes an abrupt bend and its current is very sluggish. The city lies within and hugs the periphery of this horseshoe. The buildings are very ancient, damp, crowded closely together, and the greater number falling into ruins. The houses have no yards, or have only a sort of narrow, damp and gloomy vestibule. Such are the dwellings of the better class. The dwellings of many of the inhabitants are little better than caves—almost subterranean—to which the term *cloaca* might be fitly applied. A third very common dwelling, or hut, is built of straw, mud and the excrement of animals. Damietta has no public garden, square or drive, and the streets are so narrow and winding that the sunlight penetrates with difficulty.

"The city is about three-fifths of a mile long by two-fifths wide, and into this space is crowded a population of thirty-five thousand, all natives with the exception of a few Syrians and an occasional European. During eight days in the middle of June this crowd is increased by about fifteen thousand people, who gather into Damietta to attend the annual fair of Sheik Abou El-Maati, the close of which festival was this year signalized by the outbreak of the cholera. The inhabitants are sea-faring people, with the exception of a few merchants and rice cultivators. These sailors and fishermen, including the rich natives, live almost exclusively on fish and rice, the poorer class giving preference to a rotten herring called *tissikh*. The only drink is water. The wealthy own cisterns which are filled, for the season, during the annual overflow of the Nile. The rest of the people get their drinking water directly from the river or from a canal which flows through the eastern portion of the city.

"Damietta has sixty mosques and four public baths. These contain a considerable number of privies, the excrement from which, together with that from the private dwellings, is thrown into the Nile or into the canal. The city is also surrounded by its cemeteries which, likewise, do duty for the neighboring country. Besides a great deposit of rotten fish in the centre of the city, there are in several places a large number of ruined inclosures heaped with filth. Piles of excrement lie uncared for in the streets

*This report is printed in the *Journal d' Hygiène*, Paris, 1883, and a translation of the same by the writer of this paper may be found in *The Sanitary News*, Chicago, 1883.

and alleys, and near one gate of the city there is also a great pit full of fecal matter. This pit is cleaned by pumping out its contents, which are permitted to flow away in open gutters. Rice-fields and marshes surround the city. Special causes of insanitation have existed this year, as follows: The shores, and in some places the bottom of the river, strewn with thousands of dead animals, were exposed to a burning sun by the drying up of the water during a prolonged drouth the bodies of dead animals gathering in the elbow of the Nile at Damietta on account of the low water and the sluggish current. During the fair the flesh of animals which had died of an epidemic typhus fever was eaten in great quantities, and the skins of these animals are now stored in the town. The cholera epidemic began June 22. It broke out in the most crowded and unclean part of the town, among the poorer class of people who obtained their drinking water exclusively from the Nile or from the canal, and it was for a time confined to this part of the city. The disease remained localized for some time, but was afterward carried from Damietta to Port Said, Alexandria, Ismailia, Suez, etc. Warm, calm days seemed to favor its spread: cool, windy ones to check it. A diminution in its violence was observed after the removal of a large number of carcasses from the river, and a mathematical and well-nigh miraculous coincidence was noted between the rise of the Nile and the subsidence of the disease."

According to Liebermeister the total deaths from cholera in Egypt in 1883 were over 18,000. Had the cities of southern Europe been clean and well-sewered, the cholera, having used up all available material, would have died out in the filthy Nile cities in 1883. Such unfortunately was not the case. Toulon, Marseilles, Naples, and other places in France, Italy, and Spain, were only less filthy than the towns of lower Egypt, and in 1884 cholera crossed over into Europe making its first appearance in Toulon, the dirtiest of all the European ports,—a city of 70,000 or 80,000 inhabitants, destitute of sewers, and accustomed to dump its filth indiscriminately into the streets.* From Toulon the cholera soon spread to Marseilles, Naples, Genoa, and surrounding towns in France and Italy.

The disease apparently died out in the fall and winter of 1884, like a fire when the fuel is consumed, but it was really only smoldering, and this year (1885) has again appeared in Marseilles, and has spread to many parts of Spain, where it now (June 26–30) daily numbers its victims by the hundred (400–600).†

The unsewered and insalubrious condition of Marseilles and Naples has been mentioned previously in considering typhoid fever. A distinguished engineer, M. Guérard, studied and charted the Marseilles epidemic of 1884. He shows very clearly that the greatest number of victims were in streets destitute of sewers. The mortality in the unsewered parts of the city was much greater even than in the very dirtiest and most crowded of the sewered portion. According, also, to the health officer, Dr. Albenois,‡ the cholera of 1884 was confined chiefly to the central and insalubrious parts of the old city. Those parts of the city destitute of drainage and containing a dense and wretched population acted as centers of infection. The parts of the city scourged by cholera were also the ones specially subject to typhoid fever. Dr. Albenois attributes many cases of cholera to the use of water from infected wells.§ As before stated, only a limited portion of Marseilles has drains or sewers of any sort, good or bad. Very little attention

* "A Toulon comme en Egypte, ce n'est pas 'le tout à l'égout' qui est en vigueur, c'est bien plutôt le 'tout à la rue'."—MM Vallin et Hudelo, *Revue d'Hygiène*, Paris, April 20, 1885.

† The ravages of cholera in Spain have been much worse than could have been anticipated when this paper was written. Owing to the extremely filthy condition of the Spanish cities and villages, the disease spread rapidly and for many weeks the cholera deaths exceeded a thousand a day. On September 21, while the disease was still virulent and wide-spread, the total deaths were estimated by the Spanish authorities at upwards of 15,500. At this writing, December 1, the epidemic has disappeared. The total cholera deaths in Spain in 1884 must number nearly or quite 100,000, and the cases upward of 300,000.

‡ *Bull. mensuelle du bureau de démographie de la ville de Marseille, Mar.*, 1885.

§ Striking examples are given in Wilson's *Hand Book of Hygiene*, second edition, Philadelphia, 1873, pg. 176, *et seq.*, of the spread of cholera in England and Scotland by infected drinking water. The celebrated case of the Broad street well in London is familiar to all. Cases are cited by Dr. Albenois and others where it seems impossible to doubt that the disease arose solely from breathing an infected atmosphere, although it is unquestionably more generally propagated through infected water.

is given to sanitary matters by the municipal authorities, who look favorably on the work of a board of health so long only as it makes no demands on the public exchequer. Their ignorant parsimony would not even grant the pittance of 3,000 francs, necessary to make a careful sanitary study of the epidemic of 1884.

Naples has long been celebrated as one of the most beautiful cities in Europe. It commands a magnificent sea view, and possesses many natural sanitary advantages. It could be made one of the best drained and most salubrious cities in Italy. No advantage is taken of its resources. Naples is the most crowded city in Europe, and probably the dirtiest of the larger cities. The sanitary condition is deplorable. The water-supply is scant; there is no sewer system, and the underground drains are stagnant, festering pools of corruption, which, in connection with thousands of overflowing privies, saturate the soil and poison the wells. Nearly all the wells receive more or less drainage from vaults and cess-pools, and the soil is annually becoming more and more completely saturated with excrement of men and animals.

Out of a population of 500,000, at least two-thirds live in damp underground grottoes packed "like herrings into a barrel." A recent writer thus describes the dwellings of the lower classes of the Neapolitans:*

"We were walking on a bright, balmy day in May along the broad boulevard-like Toledo, then above the Riviera di Chiaia, the spacious, glorious bay of Naples spreading out before us, Vesuvius smouldering in the distance. Without any word of warning, I stopped at what seemed merely a jut of broken wall on the left hand, and said: 'We will go down here;' and surely 'out of the sudden glow' down a slippery, slimy, broken, natural staircase 'into the dark we trod,' and were suddenly surrounded by clamorous voices, some of wonder, some of welcome. We made our entry into the grotto of the *Rampe di Brancaccio*. This is a cavern branching out in various directions, excavated in the tufa rock. It is divided into about fifty imaginary apartments, that is to say, nails in the wall and strings tied across divide the space of damp earth and dripping tufa roof, which is let out by the proprietor to fifty families.

* * * * * * * * * * * * * * * * *

"In what may be styled the *appartamento nobile* there is a faint glimmer of light from a grating as one of the branches of the cavern rises toward the upper air. Let your readers try to realize to themselves that every function of life before and after birth till death, the liberator, comes, is performed publicly in this grotto; that there is but one cess-pool for the two hundred human beings hived there; that every drop of water has to be fetched from a fountain nearly half a mile away, and then consider that the people are orderly, honest, law-abiding, and religious; that they keep lights burning night and day at the Madonna's shrine, and club together to pay the rent of a poor old paralytic man, who had been refused at every hospital and at the great Albergo dei Poveri; that no priest ever visits those subterraneous regions; that only the landlord or his agent or the tax-gatherer ever enters. Let them imagine the horde of rats and swarms of cockroaches that co-inhabit this grotto, the almost total absence of oxygen [?] in the atmosphere; let them remember that the people were always civil, many cheerful and even humorous, showing that they took things as a matter of course, and did not think themselves hardly used. Then, those who can conjure up the picture may form some idea of the homes of the poorer classes of Neapolitans."

See also "*Cholera in Europe in 1884*," pp. 43–4, where Consul Haughwout describes the condition of the Neapolitan poor in much the same language.

Cholera has visited Naples ten times since 1835, and always with great destructiveness (see Table XXXII.) The cases in 1873 numbered about 2,000; in 1884, about 10,000. At one time in September, 1884, the cholera deaths exceeded five hundred a day, and coffins could not be made fast enough to receive the dead. Nearly all the deaths occurred among the underground population. According to Dr. Rudolph Emmerich, England has been more lightly visited by each succeeding cholera epidemic because of the increasing perfection of her sanitary works, while Naples was worse scourged in 1884 than usual owing to the increasing filth of the soil.†

* The Nation, N. Y., Oct. 9, 1884.

† *Ueber die Cholera in Neapel u. s. w.* Archiv für Hygiene. Bd. II., Heft 4, 1884, p. 412.

Another sanitary authority, Prof. E. Fazio, of Naples, states* that the recurring epidemics of typhoid, typhus and cholera have always followed the same direction in the same quarters. The defective sewage disposal has transformed the subsoil into a vast subterranean pond, a *cloaca* of filth which percolates slowly into the wells, cisterns, and potable water conduits. Recent microscopic studies made in the laboratory of Prof. Cantani have shown clearly a constant contamination of the drinking waters.

The new water-works of Naples were formally opened May 11, 1885, and we may confidently expect a change for the better in the Neapolitan death-rate. It may be added, however, that Dr. Emmerich, who belongs to the Pettenkofer school, does not believe the Naples epidemic of 1884 can be attributed to the drinking water.

It will thus be seen that so far as regards this particular cholera epidemic the sewered cities have practically escaped, and the unclean, unsewered ones have suffered severely.

In August, 1883, a commission voted to admit excreta into certain Paris sewers in which the grade was believed to be sufficient. No relation could be traced between the cholera cases of 1884 and these sewers. The disease was also not more prevalent in 1884 than in 1873, when the sewers received much less excrementitious matter.† M. Durand-Claye also found that the cholera was *less prevalent* in those parts of Paris which are well sewered and well provided with the *fosses mobiles*.

In London, in 1832-3, cholera prevailed most extensively in Whitechapel and Lambeth, the crowded and ill-ventilated houses, streets and dead-ends of which were almost entirely destitute of drainage and water supply. In Brooklyn in 1866 the disease prevailed almost exclusively in low, encumbered and unsewered sections of the city. One-third of all the deaths were in a single small district of this character.

Similar instances could be cited by scores from every European and American epidemic. The rule is invariable—well sewered cities escape, unsewered ones are scourged, whenever cholera appears in epidemic form.

The water-supply has a great influence on outbreaks of cholera, Dr. Pettenkofer to the contrary notwithstanding. Genoa was visited lightly by cholera in 1884. The few cases (600) which did appear were traced to a water-supply infected by washing choleraic garments. The disease promptly disappeared when the use of this water was discontinued by order of the mayor.‡ It is stated that there were 61 deaths out of 68 cases in the first three days of its appearance, and that all who died had used water from the infected aqueduct.

There were 968 deaths from cholera in Paris in 1884. No arrondisment escaped, but certain quarters of the city suffered much worse than others. These were quarters noted for crowding and foul soil.§

It has often been asserted by outsiders and as often stoutly denied by Parisians, that the city water-supply has to do with her continued high typhoid

* *Le Cholera à Naples en* 1884. Reviewed in Journal d'Hygiène, Paris, Nov. 5, 1885.

† *Rapport sur l'écoulement des matières de vidange à l'égout*. Par MM Vallin et Hudelo. Revue d' Hygiène. Paris, April 20, 1885, pp. 265-279.

‡ 1. *Les Eaux Contaminés et le Choléra*. Par M. Marey. Presented to the French Academy, and printed in full in *Comptes Rendus*, T. xcix, No. 17, 27th October, 1884, pp. 667 683, although much exceeding the limits ordinarily assigned to communications; 2. *Cholera in Europe in* 1884, pp. 38 9. Gov't Press, Washington, D. C., 1885.

§ It is worthy of note, as bearing on the ætiology of the disease, that the death-rate among washerwomen in Paris in 1832 (M. Marey) was much higher than that in any other calling or profession. This high mortality among washerwomen has been noticed in every great cholera epidemic, and was also true of typhoid in Paris in 1882, as shown by M. Durand-Claye. The old clothes dealers of Paris also suffered severely, the mortality of the epidemic of 1884 being astonishingly great in the small street Picardy and the market of the Temple, inhabited chiefly by this class of tradesmen. (*Centralblatt für Allgemeine Gesundheitspflege*. IV. Jahrg., Heft I. Bonn, 1885.

mortality and with the spread of cholera epidemics. The researches of M. Marey* show that it was so in 1849, and render it very probable that it still continues to some extent. He found that in 1849 the waters of the Seine and Ourcq were both contaminated with night-soil. A map of Paris, charted by him with the cholera deaths of 1849, showed very clearly that the disease prevailed almost exclusively in those parts of Paris supplied with water from these sources. The white spots on the map denoting absence of cholera deaths corresponded to parks and other vacant places, with one exception. This notable exception was an inhabited district whose area was found to coincide exactly with that supplied with water from the deep artesian well of Grenelle, which could not be contaminated.

In all the French epidemics the city of Lyons, situated on a granite soil, and traversed by two rapid currents of water, has had a singular immunity from cholera, although it has been frequently imported by refugees. This is true also of the Departments *la Creuse*, *la Haute-Vienne*, *la Corrèze*, *le Cantal*, *le Lot*, *la Lozère*, and *le Gers*, all of which are situated on a rocky backbone against which abut the alluvial deposits of France

In 1848–9 the cholera mortality of London was 125 per 10,000 in those using the Lambeth water, taken from the Thames inside the city limits, and in 1854 it was 130 per 10,000. In those using water taken from the Thames *above the city* the mortality was only 37 per 10,000 In 1832, the city of Exeter had 1,000 cases and 347 deaths from cholera, its water-supply being from a part of the river contaminated by sewage Subsequent to this epidemic the water-supply was changed, being brought from a distance of six miles above the city. In the next cholera epidemic Exeter had in all only forty-four cases. The water was bad at Nottingham in 1832, and there were 289 cases of cholera. The water-supply was changed, and in 1849 there were only thirteen cases. So at Dumfries, Hull, Oxford, etc. In St. Louis in 1849 the cholera mortality reached the enormous proportion of 680 persons in each 10,000. At this time the city was entirely destitute of sewers, and the drinking water was wholly from shallow surface wells, into which human excrement unquestionably percolated. The water-supply of Madrid in 1865 was scanty, being only 500 cubic inches for each inhabitant. The cholera mortality was 92 per 10,000. In 1884 the water-supply of Naples, Marseilles, and Toulon was scanty, and the infected gutter-water was freely used by the lower classes.

In each epidemic, the relations between cholera and infected drinking water have been so apparent that in England, France, Spain, Italy, Russia, and America the more ignorant classes have not infrequently mobbed and driven away physicians and nurses, under the belief that they were purposely poisoning the wells.†

Another fact brought out very clearly by prior epidemics and emphasized by the present one is that cess-pools, stagnant drains, or privy-pits, into which choleraic discharges have been thrown, become sources of great danger, in two distinct ways (*a*) by infecting the atmosphere, (*b*) by infiltrations into the drinking water.

At Lille in 1832 out of 132 cases of cholera in the N. W. *arrondissement*, 122 were in the vicinity of old, stinking, porous walled drains, open or closed, destitute of proper slope, and often without any flow. Into these drains the cholera

* *Les Eaux Contaminés et le Choléra.* Comptes Rendus, Tome xcix, No. 17.

† This very year in Palermo, Italy, such scenes were enacted. The excited populace refused the aid of physicians, tore up the railroad and burned at the city gates the disinfectants sent by the government. Toward the end of September the disturbance was so great that armed force was necessary to quell the rioting.

dejections were thrown and the drinking water was drawn from shallow wells in their immediate vicinity. Out of sixty-eight deaths all but four were near these canals. (*M. Marey, loco cit.*)

Dr. Joseph von Fodor, of Buda Pesth, has studied the relations in that city of cholera and typhoid to filthy surroundings during a period of 15 years, 1863 to 1877, and in an important recent paper* shows that clean localities suffered much less than filthy ones. His conclusions may be thrown into the following form:

Typhoid and Cholera in Buda Pesth, 1863-77.

1. *Influence of filthy houses:*†

Deaths from cholera per 100 houses when the interior of the Dwelling was	1. Very clean	92
	2. Clean	199
	3. Dirty	268
	4. Very dirty	402
Deaths from typhoid fever per 100 houses when the interior of the Dwelling was	1. Very clean	165
	2. Clean	177
	3. Dirty	182
	4. Very dirty	356

2. *Influence of filthy yards.*‡

Cholera deaths per 100 houses when the Yard was	1. Very clean	188
	2. Clean	214
	3. Dirty	263
	4. Very dirty	389
Typhoid fever deaths per 100 houses when the Yard was	1. Very clean	159
	2. Clean	186
	3. Dirty	208
	4. Very dirty	282

According, also, to Dr. Emmerich (*loco cit.*), Dr. Spatuzzi found in his investigations at Naples that cholera was most apt to strike, not the dirtiest houses, but the houses standing on the filthiest soil.

I have not found any exception to my fourth proposition. In London, Paris, Toulon, Marseilles, Naples, Palermo, Buda Pesth, and many other places cholera has been observed to select with unerring certainty the localities usually scourged by fever. This inequality in the distribution of cholera cases was long since pointed out. It was first observed in London in 1832–3. Speaking of the work of the metropolitan sanitary commission of 1847 which was composed of such men as Lord Ebury, Edwin Chadwick, and Richard Owen, Dr. de Chaumont says:

"Evidence was collected from about thirty-five witnesses, and the results showed that cholera in its previous visit attacked the same places where fever was at other times prevalent; that it spread most in the most crowded places with the largest pauper population; that the existing methods of removing refuse were most incomplete; that the drains generally were badly arranged and badly constructed, and that there was the greatest difficulty in getting house drainage accomplished at all."§

* *Ueber den Einfluss der Wohnungensverhältnisse auf die Verbreitung von Cholera und Typhus. Archiv für Hygiene*, 1884, p. 269. See also a very good abstract in *Revue d'Hygiène*, Paris, April 20, 1885, pp. 346-51.

† "In den schmutzigen Wohnungen hat die Cholera nahezu die fünffache, der Typhus mehr als die dreifache Sterblichkeit verursacht, wie in Häusern mit reinen Wohnungen."

‡ "In den Häusern mit schmutzigen Höfen haben Cholera und Typhus eine etwa dreimal so grosse Sterblichkeit der einwohner verursacht, wie in den neben an gelegenen, mit rein gehaltenen Höfen."

§ Lectures on State Medicine. De Chaumont. London: Smith, Elder & Co., 1875.

This inequality of distribution was especially marked in the great London outbreak of 1848–49, which cost the lives of over 14,000 persons. In the 135 sub-districts of the city the cholera deaths ranged all the way from 3 to 278 per 10,000 inhabitants.* The old fever haunts were again the foci of the disease.

In Paris, according to M. Durand-Claye, the localities which suffered most from cholera in 1884 were precisely those which in times past have been worst scourged by typhoid fever.† Reference has already been made to similar facts brought out by inquiries at Marseilles, Naples and elsewhere.

Any recent standard authority on the history of cholera might be cited in proof of the final proposition that cholera selects the same localities in successive epidemics. It will be sufficient to quote from the elaborate memoir of Laveran (*loco cit.*). Speaking of the great epidemic of 1848–49 this author says:

"In this second general irruption the cholera followed almost exactly the same paths as in 1832, striking the same cities, the same wards, and often the same houses; it appeared at corresponding times of the year in the same localities, recognized the same local predispositions, yielded to the same exemptions. The chief difference was in a more rapid epidemic propagation, and in the development of local epidemics which endured longer and reached a greater number of persons."

I have combined in Table XXXII. for convenient reference the cholera statistics (complete or partial) of a number of European and American cities. The time and labor involved in procuring trustworthy data and making the necessary computations, have prevented my making this table, and certain others, as complete as I desired. In Chart III. may be found a graphic representation of some of the facts I have here endeavored to set forth.

IV.

Admitting that typhoid fever and cholera have been reduced by sewerage, the question arises, Has the prevalence or severity of any other disease been increased thereby? This question is often answered in the affirmative although, so far as I am aware, the most competent sanitarians are a unit in declaring that sewers are perfectly safe when built in accordance with the requirements of modern sanitary engineering. I cannot do better than quote, in this connection, from two eminent sources:

"The great engineering skill now available in all civilized countries can insure in the case of any new works that the construction of sewers shall be perfect. If an engineer can obtain good materials, good workmen, and a proper water-supply, there is no doubt that sewers can be so solidly constructed and so well ventilated that the danger of deposits in the sewers, or of sewer air entering and carrying disease into houses, is removed."‡

"In cities drained by sewers and supplied by water-works there is little chance, except when the most inexcusable carelessness has been manifested by builders and plumbers, of any contamination of the water, unless drawn from polluted sources, and if the sewers are well ventilated and the house connections properly made, there seems to be no reason why the public health should suffer from any cause traceable to sewage."§

I should be content to let the subject rest here, were it not for the fact that medical and sanitary writers are continually ascribing this or that epidemic disease, especially diphtheria, to the bad influence of the sewers, and thus prejudicing the public mind against all sanitary works. It has, for this reason, seemed worth while to inquire somewhat carefully into the soundness of this

* "*Appendix (B) to the Report of the General Board of Health on the epidemic cholera of* 1848 *and* 1849. *Report by Mr. Grainger.*" London, 1850.

† Paris correspondence of New York Medical Record, May 2, 1885.

‡ *Parke's Hygiene*, Am. ed. 1884, Vol. 2, p. 32.

§ "House Drainage and Water Service," by James C. Bayles, New York, 1876, p. 27.

belief. If sewers are prejudicial to the public health to the extent asserted, the fact should come out clearly in the course of any prolonged comparison of the mortuary records of sewered and unsewered districts. The appeal in this case, as in every other in which science is concerned, is not to imagination, not to theory, but directly to the facts themselves. For reasons which must be apparent to all, we shall be more likely to arrive at the truth by considering groups of population rather than individual and isolated cases.

DIPHTHERIA.

On the supposition that sewers increase the prevalence of diphtheria we should expect to find the disease confined chiefly to towns or, at least, more prevalent and fatal there than in country districts. The reverse of this appears to be true. In Michigan during the five years 1878–82* the deaths reported from diphtheria averaged annually 4.5 per 10,000 inhabitants. The deaths in one sanitary division, the Northern Central, greatly exceeded the mean, being 14.5. This district embraces a number of new and sparsely settled counties, containing no cities or large villages, and no sewers whatever. Three other divisions of the State somewhat exceeded the average,—the Western Division (7.8); the Bay and Eastern (5.4); and the Northern (5.3). These three divisions embrace twenty-two counties. There are many small villages, but the great bulk of the population is rural. There are no sewers of any consequence in the districts, a small portion only of two or three of the small included cities being sewered. The largest city in Michigan and, relatively speaking, the best sewered, is Detroit, situated in the southeastern part of the State, in which division the death-rate from diphtheria, per 10,000, during the quinquennium, was 3.6.

The death-rate from diphtheria in Detroit in the last two or three years has been much greater than in the State at large, but not greater than in large tracts of the State embracing an almost exclusively rural population. It must not be forgotten, however, that we are here dealing with imperfect returns. Only about one half of the deaths in the country districts are reported, while in Detroit they are nearly all—perhaps all reported. The diphtheritic death-rate, per each 10,000 inhabitants, as determined by the writer from unpublished registration returns in the office of the Secretary of State, is as follows:

MEAN ANNUAL DEATH-RATE FROM DIPHTHERIA, PER 10,000 LIVING, DURING THE SEVEN YEARS, 1877–1883, THE POPULATION USED BEING THAT OF THE STATE CENSUS TAKEN JUNE 1, 1880:

(1.) In Michigan	7.84
(2.) In Detroit	11.26
(3.) In State exclusive of Detroit	7.57
(4.) In Northern Central Division†	23.02
(5.) In Western Division‡	12.41

From this I conclude that while diphtheria is prevalent in Detroit to an alarming extent, its increase in recent years is not fairly attributable to the bad drains—sewers, so-called, but must be accounted for on the theory of personal contagion, or in some other way. The diphtheria record for the year 1884, from reports to the State Board of Health, is as follows:

* The Distribution of Deaths from Diphtheria in Michigan. Annual Report Mich. State Board of Health, 1883, pp. 111–115.

† Unsewered, sparsely settled inland district, comprising six counties—Mecosta, Isabella, Midland, Gladwin, Clare and Roscommon. The inhabitants are mostly new settlers, many of them being poor, ignorant and less well housed, clad and fed than the average population of the State.

‡ Unsewered, sparsely settled, chiefly rural district on west side of State bordering Lake Michigan, comprises seven counties—Mason, Lake, Osceola, Newaygo, Kent, Ottawa, Muskegon and Oceana.

DIPHTHERIA IN MICHIGAN AND IN DETROIT, 1884.

	Cases.	Deaths.
(1.) In Michigan	3,915	905
(2.) In Detroit	1,302	343

This is very nearly or quite correct for Detroit, but is by no means true for the State at large, where probably the cases were as many as 5,000 and the deaths 1,200 or more. Even with these figures the showing is bad for Detroit, and later I will consider at more length the relation of sewers to diphtheria in that city.

We would naturally expect diphtheria to be much more prevalent in cities than in the country, because in cities more persons occupy a given area, and more who are susceptible to diphtheritic poison are thrown into contact with individual cases. Especially ought diphtheria to be more prevalent in cities if the disease can be induced by subjecting persons to the influence of sewer air. In Boston the death-rate from diphtheria for a series of years is only a little higher than in the State of Massachusetts, and, so far as carefully kept records permit us to determine, the same appears to be true of some other sewered cities, American and European.

Dr. Farr, writing of diphtheria in 1874,* mentions as a remarkable fact that out of the same number born, more die in the healthy districts of England than in Liverpool, the most crowded city in England, the proportions per 10,000 being 10.29 and 4.42. He adds that, "The population of the southeastern division is not more than two-thirds of the population of London; and yet the deaths from diphtheria (456) exceeded the deaths from that disease (419) in London. In Wales the deaths from diphtheria (340) in proportion to population exceed the average. Generally it is more fatal where there are offensive privies than in towns with water-closets, but cases are found in the year in variable numbers in every county, and in almost every district."

In the "London Practitioner," January, 1885, in a careful review of one of the Reports of the Michigan State Board of Health, I find the following: "Diphtheria has for some years past been causing an increasing mortality in the State of Michigan, and, *as in this country*, it is not densely populated towns and cities that are most affected, but rather sparsely inhabited localities." The writer thinks diphtheria is more common in rural England than in her large cities because there are certain "conditions of soil or otherwise which are favorable to the development of the infection in country districts, and which are not so prevalent under the circumstances of town life."

I may also quote in this connection the recent opinion of an eminent Engl sh physician, Dr. Morell Mackenzie, to the effect that:

"The disease is much more common in rural than in urban districts. Whether, however, this fact points to the greater humidity which prevails in the country, or to the absence of proper drainage, is not at present certain. According to Dr. Thursfield, whose experience as a sanitary inspector extends over twelve hundred square miles, 'with a population of rather more than two hundred thousand, of which rather more than one hundred thousand are rural, the number of fatal cases of diphtheria in the rural portion is nearly three times that in the urban portion.' The same author remarks that whatever conditions seem to promote fungus growth, would appear to favor the incidence and persistence of the disease, and the explanation of the comparative immunity of towns may be the presence of something in their atmosphere inimical to such growth."†

From these statements it would appear that in England, at least, diphtheria is more frequent in the country than in the city. How is it elsewhere?

* Thirty-seventh Report of the English Registrar-General. Appendix, p. 219.

† Diphtheria: Its Nature and Treatment, varieties and local expressions. By Morell Mackenzie, M. D., senior physician to the hospital for diseases of throat and chest. Lecturer on diseases of the throat at the London Hospital Medical College, etc. Philadelphia: P. Blakiston, Son & Co., 1882.

I have had opportunity to consult only two of the Scottish Registration Reports—the twentieth and twenty-fourth—abstracts of 1874 and 1878. During these years the deaths from diphtheria were distributed as follows:

DEATHS FROM DIPHTHERIA IN SCOTLAND PER 10,000 LIVING.

District.	1874.	1878.
(1.) Large towns	4 8	3.6
(2.) Principal towns	2.7	2.4
(3.) Small towns	3.6	2.6
(4.) Main land—Rural	3.9	3.7
(5.) Insular—Rural	1.0	1.7
(6.) Scotland	3.4	2.9

According to the 21st Scottish Registration Report, as quoted by Dr. Varrentrapp,* the deaths from diphtheria in Scotland from 1857 to 1870, in proportion to population, were 25 per cent. more in the rural than in the urban districts, the mean being 2.16 for the urban and 2.71 for the rural districts.

The death-rate from diphtheria and croup, per 10,000 living, in Saxony during the six years 1873–78 was as follows;

(1.) In the 24 larger cities	10.0
(2.) In the districts exclusive of these cities	9.1

During the six years, 1879–84, it was:

(1.) In the 24 larger cities	18.0
(2.) In the districts exclusive of these cities	14.5†

No country on the globe has suffered worse from diphtheria than Russia, whose population is largely rural, and whose cities, one and all, are entirely destitute of modern sewerage. According to Dr. Varrentrapp (*loco cit*), no less than 8,563 persons died of diphtheria in Russia in 1876, and 18,698 in 1877. In the Province of Bessarabia (southwest Russia, bordering Roumania), 2,417 died of diphtheria in 1876, and 4,264 in 1877, one-fifth of all the deaths being from this disease. In Taurida and Eketerinoslav (north of the Black Sea), diphtheria appeared in 1875, and along the Dneiper carried off three-fourths of all the children under ten years. In the rural population of southwest Russia the disease was especially murderous. In Poltava the deaths from diphtheria were to the births as 3 to 2. The figures for a portion of south and southwest Russia (provinces of Charkov, Saratov, Voronesh, Tambov and Poltava) are as follows:

Diphtheria.	1876.	1877.	1878.	1879.
Cases	5,910	9,858	14,018	15,762
Deaths	1,837	4,445	5,744	5,703

The Russian physicians attributed the wide prevalence of the disease to ignorance, poverty, filth and climatic conditions.

In this connection it will be useful to compare the statistics of sewered and unsewered cities. Detroit has no *sewer system* proper, and is by no means completely or satisfactorily drained. Certain of the large drains or sewers, so-called, are clogged and in an unsanitary condition. For some years diphtheria has been widely prevalent in the city, and has been frequently attributed to emanations from the defective sewers. Never having heard any sound reasons advanced

* *Offener Brief an Herrn Dr. Erhardt, erst. rechtsk. Bürgermeister v. München, betreffend Dr. L. Winterhalter's Schrift "Zur Kanalisation von München."* Deut. viertelj. f. öff. Gesundh. Bd. xii., 1880.

† Veröffent. d. K. Gesundheitsamtes, ix Jahrg. No. 4, Berlin, July 28, 1885.

for such belief, I have been at some pains to see if any really exist. Comparing the cases and deaths in Detroit during the last two years with those occurring during a similar epidemic period in four other towns, we have the following exhibit, from which it would not appear that Detroit, with defective sewers, has suffered worse than other towns with no sewers:

EPIDEMICS OF DIPHTHERIA.

Locality.	Time Included.	Population.	Total Cases.	Total Deaths.	Remarks.
Detroit, Mich.	Two years, 1883-84.	U. S. Census 1880, 116,340. State Census 1884, 133,269.	2,671*	689*	Partly sewered. Many houses not connected with sewers. Large numbers of vaults; some wells. A fine city.
Kalamazoo, Mich...	Ten months nearly, 1884.	U. S. Census 1880, 11,937. State Census 1884, 13,912.	316	65	Partly sewered. Numerous privies. A general water-supply, but many wells. Cases chiefly on undrained marsh land, among the Dutch. Houses and yards filthy in many instances.
Ludington, Mich....	One year, 1881.	U. S. Census 1880, 4,190. State Census 1884, 5,431.	520+ (approximate.)	130+ (approximate.)	No sewers; no general water-supply. Privy system in general use. Drinking-water from shallow wells. Soil light sand.
Geneva, N. Y.....	Fifteen months, 1878-79.	U. S. Census 1880, 5,878.	448	80	No sewer system; no regular system of drainage; some surface drains. Privy system; soil honeycombed with old vaults, and saturated in places with excretal filth. Water-supply in part from mains; in part from wells. Village settled over 50 years ago.
Mt. Pleasant, Mich..	Exact data wanting.‡	U. S. Census 1880, 1,115.			Soil light sand; surface low and level, with marshes on two sides. No sewers; privy-pit system; no cemented vaults. Drinking-water from shallow wells in same yard. Houses new and of wood; scattering.

The sewers of Berlin have been accused of propagating diphtheria, but the mean death-rate from diphtheria for the last ten or twelve years has been nearly as high in Dresden, Leipsic, and Chemnitz, (?) where excretal matters are carefully excluded from the drainage systems, as in Berlin:

DEATHS FROM DIPHTHERIA AND CROUP PER 10,000 LIVING IN GERMAN CITIES.

City.	1873-8.	1879-84.
Sewered:		
Berlin	14 5	17.5
Breslau	4.7	7.5
Hamburg	7.5	7.5
Conservancy system:		
Dresden	8.6	17.7
Leipsic	10.3	11.8
Chemnitz	13.5	15.6

Dr. Alex. Spiess, associate editor of *Vierteljahrsschrift für öff. Gesundheitspflege,*

* In 1883, 1,369 cases, 346 deaths; in 1884, 1,302 cases, 343 deaths.
† Includes a few cases and deaths in county outside of city.
‡ One severe epidemic with many cases and deaths in about year 1878, and frequent outbreaks since. The rate during the first great epidemic was unquestionably higher than it has ever been elsewhere in Michigan.

Frankfort am Main, states that German physicians have not been able to trace any such connection between sewerage and diphtheria as English writers have endeavored to show. This view also appears to be that entertained at present by the best English and American authorities. It would not seem that well-conditioned sewers exert any marked influence upon diphtheria, and it is also very questionable whether defective sewers exert anything like the pernicious influence attributed to them. Between such sewers and the old vault system there is probably very little choice.

The methods for disposal of waste products are much alike in Baltimore and Cincinnati. Baltimore has no sewer system and the sewers of Cincinnati are used chiefly to carry off rainwater. In both cities the great bulk of the night-soil finds its way into vaults and shallow pits with porous sides and bottoms. Baltimore has the better water-supply. The typhoid death-rates in the two cities are much alike, but the diphtheria death-rates are wide apart, that of Cincinnati being comparatively low while that of Baltimore is very high. Were the latter disease dependent, like typhoid fever, on certain insanitary conditions growing out of failure to properly dispose of night-soil, we ought to find diphtheria about equally prevalent in both cities. New Orleans, destitute of underground sewers and very careless as to disposal of garbage and night-soil, has a low death-rate from diphtheria, while Marseilles and Turin, in much the same sanitary condition, have a diphtheritic death-rate three times as great. Berlin and Vienna are both about equally well sewered, and therefore on the "sewer gas" infection theory about equally exposed to diphtheria. Do we find their death-rates alike? By no means. The mean rate in Vienna during the last five years was only 4.2, while in Berlin it was 18.5. Again, New York and Brooklyn are the best sewered large American cities, and London, Brussels, and Frankfort are among the best sewered European capitals, but for some occult reason diphtheria is five times as fatal in the first named cities, as may be seen from the following table:

DEATHS FROM DIPHTHERIA PER 10,000 INHABITANTS IN FIVE SEWERED CITIES. MEAN OF TEN YEARS, 1875-84.

Good Sewers and Good Water-supply:	
London	1 7
Brussels	2.5
Frankfort	3.6
Mean	2.6
Equally Good Sewers and Better Water-supply:	
New York	12.0
Brooklyn	13.6
Mean	12.8

If there is any direct connection between sewerage and diphtheria we ought also to find the disease less prevalent in cities in proportion as the plumbing and soil-pipe ventilation is perfect. This does not appear to be true. Brooklyn is conceded to be one of the best sewered cities in the United States. During the last ten years the sewers have been cleaner and in better working order, and the houses freer from sewer-air than ever before, and yet diphtheria has been more prevalent by far than in earlier years, when the same sewer connections existed, but with much less perfect plumbing and ventilation.

Again, on the "sewer gas" theory, diphtheria ought to show a marked pref-

erence for the sewered districts of a city. Drs. Littlejohn, Fergus, and Russell, apparently found this true for Glasgow and Edinburgh, but it may be said that their deductions cover too short a period to be entirely trustworthy. In other localities it has not been found true even for short periods. Soyka (*Loco cit.* pp. 30–33) is the most recent author to study this subject exhaustively. He found the mean annual mortality from diphtheria (croup included) in Munich during the six years, 1875–80, to have been 12.9 per 10,000 inhabitants, the mortality of the sewered districts being below this average and that of the unsewered one above, as follows:

RELATIVE PREVALENCE OF DIPHTHERIA IN MUNICH, 1875-80.

Divisions of city.	Mean Death-rate per 10,000.
Group I. Sewered streets on the terrace	11.4
Group II. Sewered streets in the valley	12 5
Group III. Streets with old canals	10.5
Group IV. Streets without sewers	15.2
Whole city	12.9

Exclusive of the deaths occurring in the "*Heil-und Pflegeanstalten*," which he would exclude, the mean rate in Gr. I. was 11.5; Gr II., 10.5; Gr. III., 10.7; Gr. IV, 15.7. Diphtheria is especially a disease of early life, and, as Soyka observes, will be most prevalent where there are most children. He would therefore attribute the higher mortality of Group IV. not to want of sewerage but to the fact that during the period under consideration Group IV. had a relatively greater number of children than Groups I., II., and III. The want of drainage may also have been a somewhat favoring condition.

An editorial in *The Detroit Medical Age*, February 14, 1884, on "Sewerage and Diphtheria in Detroit," attributes the disease to the defective sewers, and says it has been especially prevalent along the line of one clogged sewer. This might well be true without militating against my argument, for I do not include foul and stinking drains in my definition of sewers, but that it is true does not appear to be clearly established. In the year 1884, Prof. J. E. Clark, of the Michigan College of Medicine, assisted by Drs. Andrews, Chittick, and Wyman, all well known Detroit practitioners, gathered statistics of 125 average cases of diphtheria with especial reference to their origin from "sewer-gas" infection. Over fifty per cent of the cases were found to be absolutely removed, by virtue of no house connection with the sewer, from the remotest suspicion of being caused by "sewer-gas" and in a large per cent of the remainder Dr. Clark thinks it would require the most subtle logic to give tenability to a theory connecting the two.* It may be added that while the general sanitary condition of Detroit, the sewers included, is, to say the least, certainly as good to-day as it was five or ten years ago, the disease in question has doubled and quadrupled its prevalence within five years.

As a matter of fact it cannot be denied that in recent years diphtheria has increased in many places without reference to sewers. The ups and downs of the disease are very curious. An inspection of the appended tables will show this very clearly. One year the disease may prevail extensively in one locality and be rare in another; the next year the reverse may be true. It may be very common in some city for a series of years, then almost disappear, and again return after some time without apparent reference to sanitary conditions. In the larger English cities the sewerage facilities were greatly extended during

* Relation of Diphtheria to Sewage in Detroit, by Prof. J. E. Clark, M. D., Detroit Lancet, June, 1884.

the ten years 1870–79. This was followed by a corresponding diminution of diarrheal diseases, but there was no marked change in the death-rate from diphtheria and its congeners, as may be seen from the subjoined table:

MORTALITY PER 10,000 INHABITANTS FROM DIPHTHERIA IN 20 LARGE ENGLISH CITIES COMPARED WITH THAT FROM OTHER COMMUNICABLE DISEASES.*

Disease.	Mean of ten years— 1870–79.	Year 1879.
Diphtheria (croup not included)	1.1	1.3
Scarlet fever	8.9	8.4
Measles	5.1	5.8
Whooping cough	7.4	7.4
Diarrhea	12.4	5.5
Fevers	5.5	2 9

I have not been able from the statistics at my disposal to establish any constant or well-defined relation between this disease and the presence of sewers, nor do I think any such relation will be found to exist.

Dr. Henry B. Baker and others have shown that diphtheria exhibits a marked tendency to rise and fall by periods of years, *i. e.*, to run in *epidemic waves*. In this respect it behaves much as do small-pox, scarlet fever and other *contagious* diseases when left to themselves. Its periods of greatest prevalence bear no relation, however, to those of the two *communicable*, non-contagious, "filth diseases"—cholera and typhoid fever. It would seem that anyone studying carefully the fluctuations of diphtheria must reach the conclusion that it is not, properly speaking, a "filth disease," but ought rather to be classified with small-pox, scarlet fever, and other diseases which spread by direct contagion. In cities where the unsanitary conditions are nearly constant, and where, on the supposition that diphtheria is a "filth disease," we should be able to count upon it as a pretty nearly constant factor in the general death-rate, we frequently find the greatest variability. In other words, the disease behaves exactly like the other contagious diseases, and not like the non-contagious communicable ones.

It has been pointed out repeatedly that whereas cholera, yellow fever, and typhoid fever prevail chiefly in the hot season when decomposition is greatest, diphtheria is a winter disease prevailing most extensively and severely at a season when decomposition is least. I have found no exception to this rule. The following statistics are given as illustrative:

Influence of Season on Diphtheria.

(1.) STATE OF NEW HAMPSHIRE.†

Per Cent. of Deaths by Quarters in 1883.

Time of Year.	Diphtheria.	Croup.
First Quarter (January, February and March)	35	30
Second Quarter	13	20
Third Quarter	22	16
Fourth Quarter	26	31
Not stated	4	3
	100.00	100.00

* From tables 55, 57, and 58 of the forty-second Annual Report of the Registrar-General, London.
† Registration Report of N. H., 1883, p. 129.

(2.) STATE OF MASSACHUSETTS.*

Per Cent. of Deaths by Months, mean of 20 Years, 1863-82.

Time of Year.	Diphtheria.	Croup.
January	10.75	12.11
February	8.50	9.49
March	7.87	9.82
April	7.23	8.08
May	6.88	6.32
June	6.41	4.43
July	5.81	3.62
August	5.60	3.51
September	7.60	5.74
October	10.67	10.34
November	11.27	13.22
December	11.40	13.41
Not stated	.01	
	100.00	100.00

(3.) STATE OF RHODE ISLAND.†

Per cent of deaths by months and by quarters.

Time of Year.	Diphtheria.—(Mean of 22 years—1858-79.)		Croup.—(Mean of 27 years—1858-79.)	
	Mean.	Total.	Mean.	Total.
First quarter:				
January	9.25		12.43	
February	6.63		10.70	
March	7.54	23.42	8.65	31.78
Second quarter:				
April	5.64		7.07	
May	6.30		4.91	
June	6.40	18.34	4.80	16.78
Third quarter:				
July	5.01		3.14	
August	6.00		2.83	
September	9.14	20.15	6.47	12.44
Fourth quarter:				
October	13.34		10.64	
November	12.99		13.68	
December	11.76	38.09	14.68	39.00
	100.00	100.00	100.00	100.00

* 41st Reg. Report of Mass., 1882, p. 84.
† Twenty-eighth Registration Report of Rhode Island, 1880, p. 134.

The exciting cause of diphtheria is unquestionably a specific contagium, capable under certain conditions of retaining its infecting power for a long time. All recent authorities in etiology admit this, and the experience of great numbers of health officers and local boards serves to confirm the belief. Our present knowledge of the disease can be satisfactorily interpreted on no other hypothesis. Moreover, it would appear that very recently Dr. Rudolph Emmerich has succeeded in isolating the *contagium virum* (a bacillus) and in causing genuine diphtheria in pigeons by inoculation of pure cultures of this fungus.* Admitting the bacillary nature of diphtheria, we have an easier explanation of its spread than by the roundabout way of the sewers, i. e., by the direct contact of well persons with the sick or convalescent, and by the transmission of infection through books, letters, playthings, clothing, bedding, furniture, walls. It is possible the disease may arise *de novo* in some instances, but the whole tendency of modern etiological research is against any such view. It is not always possible to trace the source of infection in other contagious diseases, not even in small-pox, but we are not thereby forced to the conclusion that they must arise independently of any specific contagium. Such reasoning would be in the highest degree absurd. The belief that diphtheria is due to a specific micro-organism of some sort receives confirmation from the fact that this disease, like all the other contagious diseases, is spread by the crowding together of persons in dwellings or in places of public gathering. In East Boston for a series of years (January, 1878, to December, 1882), there were frequent epidemics of diphtheria, attributed by many to the influence of sewers. Dr. Ernest W. Bowditch, who carefully investigated the outbreaks, states that the disease was not confined to any one locality but was quite evenly distributed. He did not find the disease more prevalent in the sewered than in the unsewered parts of the district, but he did find that there was a marked cessation of the disease whenever the school vacation occurred.† Dr. Henry B. Baker showed the same to be true of an epidemic occurring in the city of Lynn, Mass., in 1876, there being a marked falling off in the number of deaths coincident with the closing of the schools.‡ Similar testimony comes from many sources and is not disputed. Indeed, these facts are now so well understood in Michigan that on the first appearance of a case of diphtheria all the children of the family are dismissed from school and isolated from their neighbors as completely as possible. In case the disease shows any tendency to become epidemic, the schools themselves and all public gatherings are prohibited. The results in many instances have been most happy. If the isolation is complete and the subsequent disinfection thorough, the disease disappears.

The statistics relied on chiefly by the opponents of the water-carriage system of sewerage are those given by Dr. Jas. B. Russell, medical officer of health of Glasgow, in his writings on "Sewers as a Cause of Diphtheria and Typhoid in Glasgow,"§ and by Dr. Littlejohn of Edinburgh in various reports. Dr. de Meyer, Dr. Fergus, Dr. Winterhalter, and a few others have given support to the same view. With reference to all these anti-sewer statistics it may be said that the investigations cover too brief a time and too limited an area to warrant any broad generalization. Sufficient care, also, does not always appear to have been taken to eliminate all possible sources of error. It has been shown already

* See two very interesting papers by Dr. Emmerich, *Tr. Vmr. Cong. Int. d'Hyg.*, 1884, and *Archiv für Hygiene*, 1885. Recent German experiments have shown that Oertel's diphtheritic micrococcus is only a concomitant. *Berliner Klinische Wochenschrift*, July 6, 1885.

† Eleventh An. Report of the Board of Health of the city of Boston, 1882-3, pp. 42-45.

‡ The Relation of Schools to Diphtheria. By Henry B. Baker, M. D., Sec. Mich. St. Bd. of Health Transactions of the Am. Pub. Health Asso., vol. vi.

§ See British Medical Journal, May 11, 1878. Also, The Sanitarian, Vol. 6, p. 354.

for extensive populations covering great tracts of country, that diphtheria is more prevalent in unsewered rural communities than in cities, and the meager evidence advanced to meet this argument is of inconsiderable moment. Admitting, however, the inference drawn from Dr. Russell's statistics, we have no sound argument against sewers *per se*, but only an argument in favor of *properly constructed sewers*. Since, if diphtheria is really a "filth disease," that method of sewage disposal is best which most promptly and completely removes all filth from the house and its vicinity. The sewers of Glasgow are imperfect, and the plumbing of the water-closets, sinks, and out-houses leaves much to be desired. The sewers and house connections of 236 properties in Glasgow were tried by the smoke-test during the year ending February 20, 1883, and only seven found to be in good sanitary condition.* However, 236 are by no means all the Glasgow properties which have defective sewer connections as Mr. Mcleod admits, and as the following quotation from Dr. Christie will make plain:

"Last winter considerable quantities of chemical refuse of a very fetid description had been discharged into the sewers of one district of Glasgow, the result being an extremely offensive odor, extending over a considerable area of the city, which was recognized both in the public streets and in the houses. The most strenuous efforts were made by the local authority to discover the authors of the nuisance, and I believe that these efforts were successful. Much public indignation was excited, and numerous letters appeared in the public prints from indignant correspondents. I ventured, however, to express the opinion that the authors of the nuisance should have been handsomely rewarded, as they had applied on a very large scale, and free of expense, the smoke-test to the drainage system of the city." †

Consequently, admitting all to be true that is charged against the Glasgow sewers proves nothing against properly constructed works. Nor does this admission in any sense compel us to accept the statements of Dr. de Meyer and other advocates of pneumatic sewerage to the effect that a defective water-carriage system is worse than no system. A vast array of statistics proves the contrary. Diphtheria comes and goes without much reference to sewerage, while the extent and severity of typhoid fever and cholera are in inverse proportion to the extent and completeness of the sewer system, these diseases being most prevalent in unsewered cities, less prevalent in partially sewered cities, and least prevalent in cities having complete and well built sewerage systems.

Without entering into further detail the conclusions which I have reached, and which appear to be well established by the facts now at our disposal are:

(*1.*) *Diphtheria is as frequent in the country as in the city, i. e., in non-sewered as in sewered districts.*

(*2.*) *Diphtheria has been more frequent and fatal in certain rural districts than in any city whatsoever.*

(*3*). *Diphtheria is not more frequent or fatal in sewered cities than in unsewered ones.*

(*4.*) *Of two given cities, equally well or ill-sewered, diphtheria, during a long series of years, may be widely prevalent in the one and rare in the other.*

(*5.*) *Certain sewered cities have never suffered seriously from diphtheria, while others have been afflicted very much worse in recent years* (*i. e since the houses have been protected from sewer-air*), *than formerly when with the same sewers, but much less perfect plumbing, flushing, and ventilation, the sewer-air found its way into a majority of the houses.*

* Report by Kinneth Mcleod before Glasgow Health Committee. Sanitary Record, London, 1883, p. 463.

† *National and Local Precautions Against Cholera.* By James Christie, A. M., M. D. Glasgow Sanitary Journal, February 13, 1885, pg. 365.

(*6.*) *When an epidemic of diphtheria appears in a city the sewered and unsewered portions generally suffer alike.*

(*7.*) *No relation of interdependence can be traced between diphtheria and the sanitary state of a city, such, for example, as enables us to predict with almost absolute certainty the typhoid fever mortality of a city from a knowledge of its sanitary condition, or conversely, the sanitary condition from its typhoid mortality.*

(*8.*) *The annual mortality from diphtheria fluctuates greatly, and this, too, in cities where the sanitary conditions are very nearly constant.*

(*9.*) *Diphtheria is a disease of cold weather, being most active when putrefactive decomposition in sewers is presumably least so.*

(*10.*) *Diphtheria is a contagious disease, transmissible from person to person and place to place, like small-pox and scarlet fever.*

(*11.*) *The closing of schools and other places of public gathering checks an epidemic; and the isolation of the sick from the well, with the subsequent proper disinfection of the sick room and its contents, extinguishes it.*

(*12.*) *The data relied upon to prove a connection between sewerage and diphtheria either cover too short a period to be trustworthy, or are drawn from single cities having incomplete and defective sewerage.*

If these propositions be true, it follows as a necessary corollary that:

THERE IS NO DIRECT RELATION BETWEEN SEWERS AND DIPHTHERIA.

V.

In a majority of cases, as we should expect, the general death-rate has fallen subsequent to the introduction of sewerage. In a few cases it appears to have remained stationary or become slightly higher. It must not be forgotten, however, that many factors beside the filth poisons cause disease and premature death. We are not at liberty to attribute an increased death-rate to the sewers until we have considered other possible and probable causes. To do so would be unscientific and unfair. The problem of the death-rate is extremely complex and it is often impossible to determine with exactness the part played by any individual factor, such as age, race, social condition, occupation, religion, education, food, drink, clothing, climate. If a high death-rate continues after the introduction of sewerage, it will be found on careful inquiry that the continued high mortality is due to causes powerful enough to overcome the beneficial influence of the sewers. Poverty with its incident hunger, crowding, ignorance and neglect, all of which tend to disease and death, has a marked influence. A severer struggle for existence, an increase of population to the acre, an increase of unmarried persons, or an influx of a less robust foreign element, would all be disturbing elements, and would make a material change in the general death-rate of a city. Certain of these factors might readily escape attention. In cities where tenement houses abound and crowding is great, the high mortality is usually due to an excessive number of deaths from small-pox, consumption and fevers, among adults, and from diphtheria, scarlet fever, measles and cholera infantum among children. Most of these diseases have only an indirect relation to sewerage and water-supply, but are amenable to other sanitary influences such as cleanliness, good food, pure air, warm clothing and the protective influences of isolation, disinfection and (in small-pox) vaccination. Space and time both forbid an extended consideration of this phase of my subject. A few examples only may be cited to show that sewers do not increase any disease whatsoever. Soyka (*loco cit.*) found the general death-rate in Munich

below the average in the sewered districts, and above it in the unsewered district. According to Dr. Janssens the Brussels death-rate prior to 1868 was 32.8 per 1,000. Since the completion of the sewer system it has been 26.28. From 1825 to 1868 the mean annual death-rate in Dantzic was 36.5 per 1,000 inhabitants. Toward the close of the year 1869 a water-supply system was introduced, and in 1872 the sewers were completed. From 1869 to 1872, with a general water-supply and an incomplete sewerage system, the death-rate was 34.46; from 1873 to 1884, with both sewerage and water-supply, the rate has been 28.33.

The mean death-rate in Breslau for the last nine years, 1876–84, has been 31.77, as against 33.17 in the preceding nine years, 1867–75, or, if we include 1866 (a cholera year), as against 36.15. Dr. de Meyer (*loco cit.*) states that the death-rate of Breslau has increased since the introduction of sewerage, but he was led into error by using too short a period for comparison. From 1872 to 1874 the mean annual mortality in the fully sewered districts of Hamburg was 26.8; in the unsewered districts 40.0.

There has been, says Sir James Paget, a remarkable decrease in the English death-rate during the last nine years, the chief gains being in the diminution of fevers and diseases of children. (See Table XI.)

At New Castle-on-Tyne (population 128,000), during the ten years 1865–75, by the labors of the sanitary authorities the annual death-rate was reduced from 32.3 to 21.7 in 1,000, and typhus fever was reduced to one-fifth its former prevalence. The most striking instance, however, of the great value of sanitary works is in London itself. It is a well known fact that the death-rate usually increases in a city with increase in density of the population. London has twice quadrupled its population since the seventeenth century, and yet, owing to the increasing attention paid to sanitary matters, the death-rate has steadily fallen away, so that now it is less than one-half what it was formerly. Indeed, in this vast city of 4,000,000 people, the chances of reaching old age are nearly as good (quite as good in many parts) as in the healthier districts of rural England. The mean annual mortality of the rural districts of England during the thirty-one years, 1851–81, was 19.4; that of the urban districts during the same period was 24.0; that of London was 23.5.* The mean annual mortality of London during the last fifteen years has been about 22.5, as against 24.4 in the thirty-two years 1840–71, 36.0 in the ten years 1746–55, and forty-two in the ten years 1681–90. The earlier death-rates are from Greenhow, as quoted by Pettenkofer, and are those of the most favorable decades. According to Dr. Farr, the mortality of London during the second half of the seventeenth century reached 80.0 per 1,000, and during the eighteenth century, 50.0 per 1,000. In certain quarters of London, *e. g.*, Lambeth Square, the substitution of modern water-closets and self-cleansing house drains for the old reeking cess-pools has reduced the annual mortality fully two-thirds.

In this connection the following from a recent address by Douglas Galton is of especial interest:

"In the metropolis [London] the density of the population has increased since 1841 from twenty-five persons to an acre on the average up to forty-nine persons to an acre in 1880.

"The mortality in the decennial period 1841–50 was 24.8 per 1,000. According to the increase from the law of density it would have been 26.2 per 1,000 in the decennial period 1871–80. But the mortality was actually 23.7 per 1,000 in 1851–60, and 24.4 in the decennial period 1861–70, whilst in the decennial period 1871–80, it was only 22.5 per 1,000.

"The great works for the drainage of the metropolis were commenced in 1859, and may be considered to have been completed by the termination of the decennial period 1861–70; and the diminished death-rate of the last ten years may fairly be attributed to the improved sanitary condition of the metropolis, arising from these works.

* Forty-fourth Annual Report Registrar-General, London, 1883.

"In Glasgow, great efforts have been made to improve the water-supply, and the dwellings of the poorer classes. Until the last ten years there is no continuous ten years in the history of Glasgow which would not give a death-rate of thirty per 1,000. The death-rate during the last decade was as follows: 1871-75, 30.29 per 1,000; 1876-80, 25.89 per 1,000; and it was 24 per 1,000 in 1882."*

The Glasgow death-rate in 1883 (suburbs included) was 26.63; in 1884, 24.61. The mean annual mortality of twenty large English towns during the ten years 1869–78 was 24.9, in the year 1879 it was 22.4.† Since 1879 there has been no marked increase of mortality in any of these towns, while in some of them the death-rate has decreased still further.‡

The character of the population in the rapidly growing American cities changes so frequently that general death-rate statistics are not very determinate. Dr. Rauch finds, however, that the sewering of Chicago has had a marked beneficial influence on the death-rate. His figures are as follows: §

MEAN ANNUAL DEATH-RATE OF CHICAGO.

Fourteen years, 1843–56, prior to sewerage	37.91
Fourteen years, 1857–70, following the introduction of sewerage in 1856	23.97
Fourteen years, 1871–84, with more complete sewerage and better water-supply	21.40

Until recent years, Memphis, Tenn. (pop. 35,000), has been one of the filthiest cities on the continent, a second Toulon, although well located for sewerage. Typhoid fever was endemic, and cholera and yellow fever were frequently and disastrously epidemic. The last great epidemic of yellow fever, 1878–9, swept away hundreds of people,‖ making such havoc that the whole country became alarmed. The apathetic citizens driven finally to choose between utter extermination and sanitary reform, chose the latter alternative and introduced Waring's Separate System of Sewerage. At this time there were in Memphis no less than *seven thousand* bad cess-pools. These centers of corruption and infection were emptied and filled with clay during the progress of the sanitary works. Memphis now has thirty-five miles of sewers and drains at a cost of $275,000. Since the introduction of the sewers the former high death-rate has fallen off over one-fifth (22.5 per cent).¶

The following Table is introduced as showing in a general way the difference in death-rate of sewered and unsewered cities. For reasons already stated it cannot be used by itself as a conclusive argument in favor of sewers, but is of interest in connection with the arguments already advanced:

* Economy in Sanitation: By Capt. Douglas Galton, F. R. S., etc. Sanitary Record, London, 1883, pp. 500 6, and 546–53.

† Forty-second Annual Report Registrar General, Table 66.

‡ "There is nothing in the series of annual reports issued by this office that comes out more distinctly and unmistakably than the wonderful effect which the sanitary operations of the last decade have had in saving life."—*Forty-fourth Annual Report English Registrar-General. Abstracts of* 1881. London, 1883, p. xv.

§ *Science*, New York, July 10, 1885.

‖ 4,200 in 1878, and 485 in 1879.

¶ Report of Board of Health of Memphis, 1883, quoted in Sanitary News, 1884, p. 22.

MEAN ANNUAL DEATH-RATE IN SEWERED AND UNSEWERED CITIES IN RECENT YEARS.

	City.	Period Included.	Rate Per 1,000 Living.
Unsewered.	New Orleans	20 years, 1865-84	33.4
	Baltimore	15 years, 1870-84	25.3
	Charleston, S. C.	5 years, 1880-84	34.6
	Mexico	2 years, 1876 and 1878	52.0
	Madrid	1881	37.4
	Marseilles	5 years, 1880-84	31.0
	Naples	7 years, 1878-84	32.8
	Turin	20 years, 1865-84	27.2
	Palermo	7 years, 1878-84	24.5
	Budapest	10 years, 1870-79	42.7
	Moscow	2 years, 1879 and 1880	39.9
	Riga	13 years, 1870-1882	28.8
	St. Petersburg	Recent years	40.0
	Pekin	Recent years	50.0
	Cairo	Recent years	37.0
	Average		35.8
Sewered.	London	20 years, 1865-84	22.7
	Twenty large English cities	10 years, 1869-78	24.9
	Glasgow	10 years, 1871-80	28.1
	Edinburgh	Average of 5 years, 1874, 1878, 1879, 1883, 1884	20.9
	Brussels	10 years, 1875-84	26.3
	Berlin	15 years, 1870-84	30.5
	Breslau	10 years, 1875-84	31.7
	Hamburg	10 years, 1875-84	25.0
	Dantzic	10 years, 1875-84	28.9
	Frankfort	20 years, 1865-84	20.4
	Munich	10 years, 1875-84	33.7
	New York	20 years, 1865-84	28.0
	Brooklyn	15 years, 1870-84	24.1
	Boston	20 years, 1865-84	23.9
	Chicago	20 years, 1865-84	21.5
	Average		26.0

VI.

This paper would be incomplete without some consideration of the economic importance of sewerage and water service. In 1874 Dr. John Simon, the eminent English sanitarian, who was then Medical Officer of Health of the Local Government Board, gave it as his well-established conviction that the deaths in England each year were "fully 125,000 more numerous than they would be if existing knowledge of the chief causes of disease, as affecting masses of population, were reasonably well applied." This statement not only passed unchallenged but was accepted by other English writers as substantially correct It is equivalent to saying that one death in every four might be prevented. This statement by Dr. Simon has received direct confirmation in London and Glasgow, where active sanitary measures have reduced the death-rate over one-half in certain tenement quarters.

In studying the influence of the model tenement houses of London upon the death-rate, Douglas Galton found* that in a population of 50,000 persons lodged in these dwellings there were 1,000 less deaths per year than in an equal number of the surrounding population. He estimated that the annual sickness in this group of persons was reduced from 20,000 to 15,000 cases. The expenses connected with the sickness, death and burial of each person being put at the low figure of $25, the total saving to the community each year is considerably more than the interest on the capital expended in constructing the improved dwellings. Galton also estimated that the life of the adults in this population would be prolonged an average of ten years. Estimating the wages earned by each family at $5 per week, the total saving due to this increased longevity would amount, in one generation alone, to the enormous sum of $23,200,000.

English writers have variously estimated the sickness-rate at from 20–28 cases for each death. Making some necessary allowances in particular localities for the influence of crowding, climate, etc., we may accept the lower estimate as fairly representing the sickness-rate in all civilized communities of Europe and North America. We may also assume the unnecessary death losses in the same portion of the globe as one in three, or one in four of the total deaths.

So much, then, as to the gross loss by sickness and death, which must be transmuted into equivalent value in coin. Human sentiment and affection revolt at placing a coin value upon life. We scorn to measure human interests and capabilities by any such low standard. Yet the number and prosperity of our life and accident insurance companies, and the frequency of awards of damages by our courts for injuries done to life and limb by the carelessness of individuals or corporations, indicate a very general belief in the money value of life, and show that we are continually acting upon this supposition. What, then, is the money value of a man? There are various ways of approaching this question. Dr. Farr, whose statements deserve the highest consideration, concluded from his researches that the value of the farm hand at twenty-five years was £246 7s., this estimate being the average future wages of this class minus the average cost of maintenance. Dr Farr estimated the productive, or labor value of each man, woman and child in the United Kingdom at £159. Edwin Chadwick states that the money value of each individual of the English working classes is equivalent to a deposit of 200 pounds sterling. At forty years of age he considers the individual value to be double this sum.

In a recent paper on "Economy in Sanitation," Capt. Douglas Galton has

*Trans. San. Inst. of Great Britain. Vol. IV., 1882-3.

treated this subject in a somewhat different manner. His statements are so interesting and valuable that I quote at some length:

"Each death has been estimated to cost in funeral expenses about £5, and consequently, in the metropolis, which will soon have a population of 4,000,000, a diminution of the death-rate by 2 per 1,000 means, in the first place, a direct money saving of £40,000 a year from this cause alone. There would also be the saving from sickness, because the amount of sickness follows in some proportion the number of deaths. * * * * * "The loss from sickness arises partly from loss of earnings, and, in the younger members of a family, from the expense which the sickness causes, from loss of time and otherwise to the other members of the family, and an average of ten shillings per week would probably represent the average loss occasioned by sickness all 'round. If we assume the sickness to follow the death-rate, the diminution of 2 per 1,000 may be estimated to cause a saving of one shilling per head per annum of the population as the measure of the loss during sickness, arising from preventable diseases, in the earnings of the heads of families, and in the extra expenses caused by the other members of a family. Thus the diminished sickness-rate on the population of 4,000,000 would afford a beneficiary advantage to the population of at least £200,000 a year; or the advantage to the population from a diminished death-rate of 2 per 1,000 would amount to nearly a quarter of a million a year."

In a discussion following Galton's paper, which was read before the Society of Arts, April 25, 1883, Mr. Collins said:

"He should like to quote some figures recently given by Sir Lyon Playfair as to the death-rate in London at different periods. From 1661-69 it was 80 per 1,000; 1681-90, 42; 1746-55, 35.5; 1846-55, 24.9; 1871-80, 23; so that leaving out the years of the plague, and taking the figures from 1681, the deaths had diminished one-half. Since the habits of the people with regard to intoxication had not improved, that might fairly be considered to be the result of the sanitation which had been going on during the interval."

Sir James Paget, in a late remarkable address on "National Health and Work,"* gives especial attention to the economics of sickness.

From a careful study of the data furnished by the records of the Friendly Societies he came to the conclusion that the sickness in these groups may be taken to fairly represent that of the entire English population. The annual loss of time by sickness in the membership of these Societies is about nine days for each man, woman, and child between the ages of 15 and 65 years. This would give annually a total loss of time from sickness in the whole kingdom of about 20,000,000 weeks.

"The number is not easily grasped by the mind. It is equal to about one-fortieth of the work done in each year by the whole population between fifteen and sixty-five years old. Or, try to think of it in money. Rather more than half of it is lost by those whom the Registrar-General names the domestic, the agricultural, and the industrial classes. These are more than 7,500,000 in number, and they lose about 11,000,000 weeks; say, for easy reckoning, at £1 a week; and here is a loss of £11,000,000 sterling from what should be the annual wealth of the country. For the other classes, who are estimated as losing the other 9,000,000 week's work, it would be hard and unfair to make a guess in any known coin, for these include our great merchants, our judges and lawyers and medical men, our statesmen and chief legislators; they include our poets and writers of all kinds, musicians, painters, and philosophers, and our princes, who certainly do more for the wealth and welfare of the country than can be told in money."

Typhoid fever alone, according to Paget, "has of late destroyed in England and Wales among persons in the working time of life nearly 4,000 in the year." This loss by no means expresses the whole tax levied by the disease. "Its mortality is about 15 per cent, so that, if in any year 4,000 die of it, about 23,000 recover from it. Of these, the average illness is, on the authority of Dr. Broadbent, about ten weeks. Here, therefore, from one disease alone, and that preventable, we have an annual loss of 230,000 weeks' work, without reckoning what is lost with those who die. And the same may be said of nearly all the diseases that are most prominent in the bills of mortality."

* National Health and Work. An address delivered before the International Health Exhibition, London, Eng., June 17, 1884, by Sir James Paget, F. R. S. British Medical Journal, London, June 21, 1884. Pop. Sci. Mo., N. Y., Sept., 1884.

The most interesting, perhaps, of the recent papers on the economics of sanitation is by M. Rochard.* The economic importance of a man must be measured by what he has cost, and by what he can produce. Rochard's definition is as follows:

"This economic value represents what each individual has cost his family, the community or the State for his living, development, and education. It is the loan which the individual has made from the social capital in order to reach the age where he can restore it by his labor."

The economic value of human life depends upon the age, sex, social condition, nature of employment, and many other factors. Before any estimate can be made of the economic value of the individuals of a community we must know the relative number of males and females; of workers and idlers; of dwellers in city and country; the cost of food and clothing, and the price of the different kinds of labor, etc., in the various parts of the country. Taking into account all these factors, Rochard divided the population of France into small groups, first computing the value of a single individual and then that of each group. Combining the resultant sums, he obtained an approximate valuation for all France. The sum thus obtained was 41,321,236,656 francs, which being divided by the population (37,672,048), gives 1,097 francs, or about $219 as the money value of each Frenchman. The value of an Englishman or American, computed in this way, would probably be somewhat greater. As above stated, Edwin Chadwick determined the value of an adult laborer to be equivalent to a deposit of £200, and double this sum at 40 years of age. Dr. Farr estimated the money value of every inhabitant of England at £159. Rochard says he does not comprehend these English figures. He thinks the value of a workingman, *arrived at maturity*, is nearer the American estimate of $3,500. A Frenchman of the working classes, 20 years of age, sound and well developed, suitable in a word for the army, has an economic value of 6,000 francs, or more than five times the average value.

In the year 1880 there were 858,237 deaths in France. The economic loss by these deaths, if figured in the same way by groups of the population, urban, rural, etc., exclusive of cost of burials, amounts to 940,686,444 francs, or about $188,137,289. This is, of course, only an approximation; but it is certainly under rather than over the actual amount.

The cost of sickness remains to be considered. Rochard based his estimates on statistics from the French hospitals. In the year 1880, which he takes as a typical year, 462,357 persons received treatment in these hospitals. The entire time lost by them was 15,904,373 days, and the total deaths were 42,011. Excluding the children treated, and estimating the daily wages of the men at two francs, and of the women at one franc, we have a total loss of wages of 22,087,419 francs, or $4,417,484 in that portion of the population treated in the hospitals. To this sum should also be added the cost of physicians, nurses, foods, medicines, etc., a sum of 31,808,756 francs additional. This gives a grand total of 53,896,175 francs, or $10,779,235, as the cost of the sickness treated in the hospitals of France in the year 1880.

Subtracting the hospital deaths from the total deaths in France, we have 816,326 remaining for the civil practice. In the hospitals there were nine deaths per 100 cases. Estimating on this basis, and excluding minor illnesses, such as would not find their way into hospital practice, we have for the civil practice in France 9,005,607 cases. This sum multiplied by 34, the average

**La valeur économique de la vie humaine, et sa comptabilité.* Par M. Jules Rochard, de Paris. *Comptes rendus et mémoires du cinquième congrès international d'hygiène et de démographie, à la Haye*, 1884. Tome I., pp. 62–96.

number of days lost by each hospital patient, gives 306,190,638 days' loss from sickness in France outside of the hospitals. Estimating the cost of private treatment at one franc per day, or one-half that of hospital treatment, we have a total cost, from the serious maladies alone, of 306,190,638 francs, or about $61,238,127. Estimating the wages as before at two francs per day for men and one franc for women, and proceeding on the supposition that the relative proportion of males, females, and children is about the same in private practice as in the hospitals, the entire wage loss on account of sickness foots up to 348,333,770 francs, or about $69,666,754. Adding this sum to the cost of treatment, we obtain a grand total of 654,524,408 francs, or about $130,904,882 as the cost of sickness in the civil practice of France in 1880. This important consideration must, however, be borne in mind. The hospital practice is recruited solely from the poorer classes, while the sick treated at home include the well-to-do classes—merchants, mechanics, high public functionaries, and members of the liberal professions, whose labor represents a much larger sum. This estimate is, therefore, *under* the actual value.

Adding cost of treatment and loss by sickness in the civil practice to that in the hospital practice, we have in France a total yearly *loss by sickness* of 708,420,583 francs, or about $141,684,116. Uniting to this the *mortuary* loss, we obtain the enormous sum of 1,649,107,027 francs, or about $329,821,605, as the annual money loss caused by sickness and death in France. If, says Rochard, we could diminish this sum by one-tenth only, there would result to France an annual saving of *one hundred and sixty-five million francs*, and he adds: "I shall prove to you that hygiene is able to do much more than this!"

Rochard's estimate of the economic possibilities of sanitary science is very reasonable, since at least one-half the total death loss in civilized communities arises from diseases which are unquestionably to a great extent preventable. In this connection some of Rochard's own statistics on cholera and typhoid fever are of great interest. Public calamities, such as famines or hard winters, bear with greatest severity on puny children, or on the old and infirm. In a social point of view they are much less disastrous than epidemics of typhoid fever or cholera, which strike down the middle-aged and strong. The deaths from cholera during the first three European epidemics were about 3,400,000. Estimating the value of each person at 1,000 francs, the money loss would be 3,400,000,000 francs, or about $680,000,000, not including the cost of treatment or the loss of time, which would not be great since the disease is swift in its course. Again, the annual mortality from typhoid fever in the standing armies of Europe is 5,669. Estimating the number of men in these armies at 2,834,600, we have a death-rate of 20 per 10,000. The value of a soldier being 6,000 francs, the total death-tax (*dime mortuaire*) from typhoid fever is 34,014,000 francs per year, or about $6,802,800. In the two armies concerning which we have most exact data, the French and German, the proportion of deaths to cases is respectively 14 to 100 (Leon Colin) and 10 to 100 (F. Glenard). Rochard estimates the number of deaths to cases in the armies of all Europe at about 12 to each 100, and the entire cost of typhoid fever to these standing armies, in round numbers, at 36,000,000 francs, or about $7,200,000 a year.

Dr. Joseph Jones has recently published* some interesting statistics, based upon the records of Charity Hospital in New Orleans. During a period of thirty-four years (eighteen years prior to the civil war and sixteen years since) no less than 132,332 cases of fever, with 15,480 deaths, were treated in this

* Letter to the Mayor of New Orleans. Report of Louisiana State Board of Health, 1881, pp. 232-3.

great hospital which is supported by the State. "If the cost of treatment of each case to the State be placed at the low figure of $20.00, then Louisiana expended during these thirty-four years, $2,646,700 for the treatment of fevers alone,—a sum sufficient to have thoroughly drained and sewered the whole territory" * * * * "If the value of a citizen to the State be rated at $1,000, then the city of New Orleans has lost during the thirty-four years $56,478,000 by [deaths from] fevers alone." In conclusion, Dr. Jones adds: "We may therefore affirm that nearly one-half of the deaths in New Orleans during the past thirty-four years (118,095) were caused by preventable diseases, the remedy for and the diminution of the same being effective drainage. From these diseases New Orleans has lost in thirty-four years, according to reliable data, $118,094,000."

Intelligent persons will find no difficulty in admitting Paget's apothegm: "The greater part of the national wealth is the *income* from the work which is the *outcome* of the national health." We have seen as regards England and France to what extent this national income is diminished by diseases amenable to sewerage and water-supply. Let us now consider briefly the cost of typhoid in Europe as a whole.

According to the eminent French statistician, Bertillon, the average typhoid fever mortality per 10,000 living in twelve large European cities* in 1883 was 5.1. Rochard, following Bertillon, takes as probably representing the typhoid mortality of all Europe one-half that of 1883 in her twelve great cites, *i. e.*, $\frac{5}{2}^1$. This estimate is too low, one year being too short a period to give a determinate average. If, instead of one year, we include the last five years and exclude England which is fairly well-sewered, we shall have a European rate much greater than $\frac{5}{2}^1$, probably as great as $\frac{1}{2}^0$ or $\frac{1}{2}^2$ per 10,000 living. The approximate population of Europe is 327,700,000, and Rochard, proceeding on his estimate of $\frac{5}{2}^1$ gets a typhoid mortality per year of 81,925 persons, and a money loss of very nearly 100,000,000 francs. He thinks it would be possible to diminish this loss by at least one-fourth, and thus save twenty-five millions. My own opinion is that Rochard's estimate of $\frac{5}{2}^1$ should be doubled, and that the typhoid fever mortality of Europe could be reduced at least three-fourths.

In conclusion, let us inquire how the same fever affects the financial prosperity of our own country. The average typhoid fever mortality of the last ten years, 1875–1884, in ten large American cities† has been 4.9. This may be assumed as fairly representing the yearly average in all American cities. If there is any error it is in placing the estimate too low, since nearly all the cities named enjoy the advantages of good water-supply and partial sewerage, and some of them, *e. g.* Brooklyn and New York, are specially favored. The mortality in the villages and country districts will not be found to vary much from this estimate. In the villages, if anything, the average is probably slightly higher.

The typhoid fever mortality in Michigan, after being corrected for deficiencies in the returns, approximates a yearly average of between 5 and 6 per 10,000.

The statistics of Massachusetts, which are the most reliable we have for any large State and long period, give an average typhoid fever mortality for the past ten years of 5.0 per 10,000. From a somewhat careful study of the subject I am led to believe that we may safely assume the annual tax levied on the people

* London, Paris, Berlin, St. Petersburg, Vienna, Glasgow, Brussels, Marseilles, Copenhagen, Edinburgh, Christiana, Magdebourg.

† New York, Brooklyn, Boston, Chicago, Cincinnati, St. Louis, Baltimore, New Orleans, Charleston, S. C. (average of four years 1880-3), and San Francisco (average of four years 1873-6).

of the United States by typhoid fever to be at least 5 deaths to each 10,000 inhabitants. The population of the United States in 1870 was 38,558,371; in 1880 it was 50,155,783. Assuming fifty millions as the average population during the ten years, 1875-84, the number of deaths from typhoid fever would amount to no less than 250,000.

It is more difficult to estimate the money loss by reason of these deaths. I think we may safely estimate the value of each fever victim at $2,000. This is probably considerably below the actual value, since by far the larger number of all these deaths occurred between the ages of 15 and 45, or during the productive years of life. We may assume ten recoveries to each death from typhoid fever. The average duration of the disease may be placed at thirty days. In this country during the past ten years day-laborers have seldom received less than $1 per day, and teachers and servant girls seldom less than 50 cents per day, these being the poorest paid classes in the community. We may therefore place the loss of wages during this period at $1 per day, or $30 for the whole time, with no risk of over statement. The cost of medical attendance and nurses may be placed at $40, and of burial expenses at $30. All these items are very low, in fact, much too low, but to be entirely safe let us place them here. Taking these estimates, the annual loss to the State of Michigan from typhoid fever would be $1,711,500. The annual loss to Massachusetts would be $1,856,400. Assuming the yearly typhoid fever death-rate of the United States to be but 3 per 10,000 instead of 5 as in Michigan and Massachusetts, we have a total of 15,000 deaths per year, with a money loss in round numbers of $31,000,000. To this death-tax must be added an additional sickness tax of $10,500,000, making the enormous total of $41,500,000. This is the yearly waste due to a single preventable disease. It is entirely within bounds to say that the general introduction of proper sanitary measures, meaning thereby the provision of an abundant supply of pure water and the proper disposal of excreta, would reduce this loss two-thirds to three-fourths, with an economic husbanding of at least $25,000,000 a year—enough in the course of a few generations to sewer every city and village from the Atlantic to the Pacific.

The introduction of sewerage systems and water-supply systems at any cost is, therefore, the soundest social and financial economy:

(1.) Because, along with greater freedom from sickness, and a consequent important saving of time and money, it insures to the individual a greatly increased ability to earn money; and

(2.) Because the lives which are saved each year increase by so much the total population, and consequently the total bread-winning, or money-making and disbursing powers of the community.

MORTUARY STATISTICS.

TABLE I.—STATE OF MICHIGAN.

[Compiled from data furnished by the Bureau of Vital Statistics, Department of State, Lansing, Michigan.]*

Year.	Population (estimated or enumerated.)	Annual Death-rate per 1,000 Living.†	Typhoid Fever.			Diphtheria and Croup.		
			Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
c 1860	749,113							
1861.								
1862.								
1863.								
c 1864	806,745							
1865.								
1866.								
1867			361					
1868			430					
1869			437					
c 1870	1,184,282		574	4.85				
1871	1,221,719		357	2.92				
1872	1,259,156		620	4.92	4.5			
1873	1,296,593		677	5.22				
c 1874	1,334,031		610	4.57				
1875	1,384,515		433	3.13		374	2.72	
1876	1,434,999		426	2.97		489	3.48	
1877	1,485,483		446	3.00	2.7	757	5.10	5.9
1878	1,535,967		329	2.14		1,123	7.31	
1879	1,586,451		397	2.50		1,751	11.04	
c 1880	1,636,937		513	3.13		1,864	11.39	
1881	1,691,728		884	5.23		2,443	14.44	
1882	1,746,519		463	2.65	3.2	1,763	10.09	10.17
1883	1,801,310		442	2.45		1,343	7.46	
c 1884	1,856,100		513	2.76		1,390	7.49	

* The deaths occurring in the townships are collected by the Supervisors *after the close of the year*, and in this way many occurring in the early part of the year are unquestionably lost. For comparison with localities where the returns are complete the yearly totals of Michigan ought probably in each case to be nearly or quite *doubled*.

† Deaths from all causes.

c Census.

TABLE II.—STATE OF MASSACHUSETTS.

[Compiled from 42nd Registration Report of Massachusetts, and from data furnished by the Registration Office.]

Year.	Population (estimated or enumerated)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
* 1850	994,514	16.70							
1851	1,002,003	18.90							
1852	1,027,508	17.99	18.38						
1853	1,075,007	18.88							
1854	1,103,351	19.41							
* 1855	1,132,364	18.37							
1856	1,151,455	18.01							
1857	1,170,862	18.17	17.87						
1858	1,190,592	17.45		901	7.6		18	.1	
1859	1,210,656	17.33		932	7.7		32	.2	
* 1860	1,231,067	18.74		937	7.6		258	2.1	
1861	1,238,110	19.46		989	7.9		643	5.2	
1862	1,245,310	18.45	20.32	1,135	9.1	9.4	663	5.3	6.7
1863	1,252,500	22.16		1,442	11.5		1,420	11.3	
1864	1,259,710	22.80		1,344	10.7		1,231	9.8	
* 1865	1,267,031	20.64		1,694	13.4		672	5.3	
1866	1,302,989	18.14		1,091	8.4		399	3.1	
1867	1,339,968	16.99	18.55	965	7.2	8.8	251	1.9	2.9
1868	1,377,996	18.58		896	6.5		297	2.2	
1869	1,417,103	18.38		1,205	8.5		296	2.1	
* 1870	1,457,351	18.75		1,333	9.1		242	1.7	
1871	1,494,338	18.70		1,116	7.5		274	1.8	
1872	1,532,264	22.85	20.33	1,703	11.1	8.7	273	1.8	2.1
1873	1,571,152	21.58		1,406	8.9		310	1.9	
1874	1,611,028	19.79		1,147	7.1		502	3.1	
* 1875	1,651,912	21.17		1,059	6.4		1,200	7.3	
1876	1,651,912	20.09		881	5.3		2,610	15.8	
1877	1,657,265	18.91	19.49	814	4.9	4.9	2,634	15.8	12.1
1878	1,667,200	18.78		679	4.1		1,934	11.6	
1879	1,717,200	18.52		637	3.7		1,734	10.1	
* 1880	1,783,085	19.79		882	4.9		1,769	9.9	
1881	1,867,444	20.40		1,072	5.7		1,706	9.1	
1882	1,921,719	20.60	20.54	1,079	5.6	5.0	1,280	6.7	7.3
1883	1,985,335	21.20		860	4.3		1,091	5.5	
1884	2,037,390	20.70		875	4.3		1,084	5.3	

TABLE III.—CITY OF BOSTON,* MASS.

[Compiled from data furnished by the City Board of Health, or taken from the 2nd. An. Rep., Mass. St. Bd. of H., 1871, and the 11th An. Rep. Bd. of H. of the City of Boston, 1882-3.]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.†			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1846	116,865	26.41		133	11.4				
1847	122,346	31.49	31.17	300	24.5				
1848	127,827	28.66		288	22.5	17.4			
1849	133,308	38.10		149	11.2				
c 1850	138,788	26.78		104	7.5		None reported these years.		
1851	142,693	27.00		170	11.9				
1852	146,598	25.30	27.14	110	7.5	8.2			
1853	150,503	28.20		111	7.4				
1854	154,408	28.40		102	6.6				
1855	158,313	25.07		90	5.7				
1856	162,218	26.00		76	4.7				
1857	166,123	23.60	23.71	86	5.2	5.0			
1858	170,028	22.50		75	4.4				
1859	173,934	21.40		85	4.9		19		
c 1860	177,840	24.63		110	6.2		Unk.		
1861	180,735	22.00		96	5.3				
1862	183,630	22.40	24.25	74	4.0	5.7	46	2.51	
1863	186,526	25.20		130	6.9		108	5.79	
1864	189,422	27.00		117	6.2		118	6.23	
1865	192,318	23.60		137	7.1		51	2.26	
1866	195,214	22.40		101	5.2		52	2.66	
1867	198,110	22.30	23.12	91	4.6	5.6	47	2.37	2.6
1868	230,911	23.90		120	5.1		67	2.90	
1869	236,000	23.40		148	6.2		61	2.58	
c 1870	250,526	24.30		168	6.7		51	2.04	
1871	256,000	23.00		176	6.8		39	1.52	
1872	254,400	31.80	26.85	229	9.0	7.6	28	1.10	1.8
1873	260,000	30.27		243	9.3		59	2.27	
1874	313,745	24.90		202	6.4		72	2.30	
1875	360,122	24.95		227	6.3		420	11.66	
1876	352,842	23.39		145	4.1		577	16.35	
1877	363,000	20.15	21.98	156	4.2	4.2	364	10.03	12.2
1878	363,000	21.03		120	3.3		448	12.34	
1879	363,000	20.38		119	3.2		391	10.77	
c 1880	362,839	23.53		154	4.1		588	16.21	
1881	397,628	22.67		207	5.2		601	15.11	
1882	410,376	21.91	22.67	212	5.1	4.9	458	11.16	12.2
1883	427,940	22.76		198	4.6		445	10.40	
1884	427,940	22.48		216	5.4		345	8.06	

* "The city is provided very generously with water closets, yet, during the year 1871, there were removed 5,000 cords of night-soil from privies within the city limits, besides 10,000 cords of street sweepings and cesspool matter." *Fourth Ann. Rep., Mass. St. Bd. of H., Jan., 1873.*

† Typhus is included in earlier years as the distinction between the two diseases was not very clear prior to 1855.

TABLE IV.—CITY OF NEW YORK.

[Compiled from data furnished by John T. Nagle, M. D., Deputy Register of Records, Health Department, N. Y. City.]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1847	454,698	32.65		473	10.40				
1848	474,982	31.35	36.55	249	5.24	6.7			
1849	495,266	45.64		221	4.46				
1850	515,547	30.70		112	2.17				
1851	545,359	38.03		156	2.86				
1852	575,171	35.11	36.24	147	2.56	2.6			
1853	604,983	34.92		171	2.83				
1854	634,795	42.46		189	2.98				
1855	664,607	32.32		172	2.59				
1856	694,419	28.95		158	2.27				
1857	724,231	30.07	29.68	155	2.14	2.5	2	.03	.2
1858	754,043	29.44		211	2.80		3	.04	
1859	783,855	27.61		218	2.78		53	.68	
1860	805,651	28.19		232	2.88		422	5.24	
1861	818,380	27.03		245	2.99		453	5.53	
1862	831,310	25.55	28.10	417	5.02	5.0	594	7.15	7.7
1863	844,445	29.84		531	6.29		980	11.61	
1864	857,787	29.91		661	7.71		781	9.10	
1865	871,340	28.51		573	6.57		534	6.12	
1866	885,107	30.30		514	5.81		435	4.91	
1867	899,092	25.76	27.79	347	3.86	4.8	248	2.76	4.1
1868	913,298	27.25		329	3.60		277	3.03	
1869	927,728	27.13		378	4.07		328	3.54	
1870	942,292	28.84		422	4.48		308	3.27	
1871	954,636	28.26		239	2.50		238	2.49	
1872	967,142	33.76	29.90	364	3.76	3.3	446	4.61	7.8
1873	979,811	29.68		294	3.00		1,151	11.75	
1874	992,646	28.94		275	2.77		1,665	16.77	
1875	1,041,886	29.47		347	3.33		2,329	22.35	
1876	1,055,535	27.62		283	2.68		1,750	16.58	
1877	1,069,362	24.50	26.47	275	2.57	2.5	951	8.89	12.6
1878	1,083,371	24.93		245	2.26		1,007	9.30	
1879	1,097,563	25.82		178	1.62		671	6.11	
1880	1,206,299	26.47		241	2.00		1,390	11.52	
1881	1,242,533	31.08		446	3.59		2,249	18.10	
1882	1,279,560	29.64	27.76	362	2.83	3.0	1,525	11.92	11.4
1883	1,317,691	25.81		471	3.57		1,009	7.66	
1884	1,356,958	25.82		389	2.86		1,090	8.03	

TABLE No. V.—CITY OF BROOKLYN.

[Compiled from data furnished by Dr. R. M. Wyckoff, Secretary and Registrar of Vital Statistics, Department of Health, Brooklyn, N. Y.]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria.*		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
e 1845	59,574								
1846	67,374								
1847	75,174	23.64							
1848	82,974	25.25	27.50	70	8.44	6.1			
1849	90,774	33.62		34	3.75				
e 1850	98,574	39.03		20	2.03				
1851	119,915	23.83		42	3.50				
1852	141,256	22.54	26.57	43	3.04	2.8			
1853	162,597	21.55		29	1.78				
1854	183,938	25.92		63	3.43				
e 1855	205,280	18.68		30	1.46				
1856	217,556	17.13		40	1.84				
1857	229,832	24.20	21.93	46	2.00	1.9	.....	.....	0.1
1858	242,108	26.43		51	2.10				
1859	254,384	23.22		59	2.32		13	.51	
e 1860	266,661	25.92		85	3.19		135	5.06	
1861	272,551	25.63		116	4.26		165	6.05	
1862	278,441	25.70	26.71	129	4.63	4.6	219	7.87	7.6
1863	284,331	27.86		131	4.61		332	11.68	
1864	290,221	28.43		177	6.10		214	7.37	
e 1865	296,112	28.58		250	8.44		154	5.20	
1866	313,800	27.67		207	6.60		77	2.45	
1867	336,000	26.28	27.30	111	3.30	4.8	101	3.01	3.6
1868	356,000	27.88		103	2.89		133	3.74	
1869	376,000	26.09		96	2.55		139	3.70	
e 1870	396,000	24.91		111	2.80		110	2.78	
1871	410,000	25.02		92	2.24		157	3.83	
1872	423,000	30.00	25.90	149	3.52	2.5	184	4.35	5.9
1873	436,000	25.13		103	2.36		252	5.78	
1874	450,000	24.46		81	1.80		580	12.89	
e 1875	482,493	25.84		102	2.11		965	20.00	
1876	498,300	25.20		89	1.79		812	16.30	
1877	514,300	22.09	23.01	82	1.59	1.5	778	15.13	14.8
1878	531,100	20.85		59	1.11		544	10.24	
1879	548,500	21.09		59	1.08		689	12.56	
e 1880	566,689	23.33		71	1.25		1,118	19.73	
1881	583,220	24.83		99	1.70		1,169	20.04	
1882	604,356	24.84	23.39	93	1.54	1.5	631	10.44	12.5
1883	624,118	22.04		92	1.47		409	6.55	
1884	644,526	21.90		107	1.66		385	5.97	

* Diphtheria first appears as a cause of death in 1859.

TABLE VI.—CITY OF BALTIMORE.

[Compiled from data furnished by A. R. Carter, Secretary of the Health Department and City Registrar, Baltimore, Md.]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
• 1850	169,054								
• 1860	212,418	22.91		101	4.75		300	14.12	
1861	217,912	21.98		162	7.43		207	9.50	
1862	223,406	23.15	23.21	202	9.04	7.4	320	14.32	15.4
1863	228,900	24.25		168	7.34		456	19.92	
1864	234,394	23.75		200	8.53		447	19.07	
1865	239,888	19.57		171	7.13		378	15.76	
1866	245,382	22.92		196	7.99		330	13.45	
1867	250,876	20.77	22.43	235	9.37	7.8	231	9.21	12.8
1868	256,370	24.10		167	6.51		308	12.01	
1869	261,864	24.81		210	8.02		356	13.59	
• 1870	267,354	27.16		265	9.91		285	10.66	
1871	273,850	26.08		200	7.30		248	9.06	
1872	280,346	26.92	26.53	182	6.49	8.0	246	8.77	10.2
1873	286,842	27.25		235	8.19		361	12.59	
1874	293,338	25.23		244	8.32		292	9.95	
1875	299,834	24.40		187	6.24		258	8.60	
1876	306,330	24.10		184	6.01		247	8.06	
1877	312,826	28.84	24.36	235	7.51	6.1	612	19.56	13.0
1878	319,322	21.09		176	5.51		452	14.16	
1879	325,818	23.38		166	5.09		484	14.85	
• 1880	332,313	24.20		196	5.90		466	14.02	
1881	339,809	25.94		197	5.80		881	25.93	
1882	347,305	25.69	25.03	165	4.75	4.8	929	26.75	20.4
1883	354,801	26.44		126	3.55		792	22.32	
1884	362,297	22.89		151	4.17		470	12.97	

TABLE VII.—CITY OF CINCINNATI, O.

[Compiled from U. S. Census, and from Tables 13 and 14 in *Eighteenth Annual Report of the Health Department of Cincinnati, 1886.*]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid and not Classified.			Diphtheria and Croup.			Total Deaths.
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.		
1850	115,435									
1860	161,044									
1866*										
1867	199,681	17.70	19.47	215	10.77	7.6	122	6.11	6.0	3,535
1868	205,200	21.33		172	8.38		134	6.53		4,377
1869	210,720	19.38		75	3.56		115	5.46		4,084
1870	216,239	19.64		105	4.86		157	7.26		4,248
1871	220,129	22.25		137	6.22		122	5.54		4,898
1872	224,019	22.84	22.49	98	4.37	5.9	122	5.45	5.7	5,116
1873	227,909	24.75		170	7.46		113	4.96		5,641
1874	231,799	22.96		154	6.64		122	5.26		5,321
1875	235,689	22.93		154	6.53		108	4.58		5,404
1876	239,579	23.83		167	6.97		145	6.05		5,710
1877	243,469	18.19	21.10	139	5.71	5.8	165	6.78	6.7	4,428
1878	247,359	19.50		116	4.69		205	8.29		4,823
1879	251,249	21.05		128	5.09		202	8.04		5,290
1880	255,139	20.29		207	8.11		155	6.08		5,177
1881	259,639	23.50		223	8.59		166	6.39		6,101
1882	264,139	26.02	22.52	177	6.70	7.3	183	6.93	6.0	6,873
1883	268,639	22.02		179	6.66		140	5.22		5,916
1884	273,139	20.75		176	6.44		152	5.56		5,667

* City Board of Health established in 1866.

TABLE VIII.—CITY OF CHICAGO, ILLINOIS.

[Compiled from U. S. Census; and from data furnished by Dr. M. K. Gleason, Registrar of Vital Statistics, and Jno. K. Allen, Asso. Ed. *Sanitary News*.]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
• 1850	29,963								
1851	38,184								
1852	46,405	35.52	39.53	48	10.34	10.2			
1853	54,626	22.06		35	6.41				
1854	62,847	61.01		86	13.68				
1855	71,068	27.90		43	6.05				
1856	79,289	23.93		66	8.32				
1857	87,510	24.80	23.12	82	9.37	6.8			
1858	95,731	21.41		49	5.12				
1859	103,952	17.57		51	4.91		1		
• 1860	112,172	18.36		46	4.10		154	13.73	
1861	130,755	15.85		74	5.66		112	8.57	
1862	149,338	17.26	18.83	85	5.70	6.9	74	4.96	8.3
1863	167,921	20.98		149	8.87		137	8.16	
1864	186,504	21.68		192	10.29		115	6.17	
1865	205,087	17.86		190	9.26		169	8.24	
1866	223,670	26.52		203	9.08		134	5.99	
1867	242,253	19.20	22.10	165	6.81	7.9	78	3.22	5.1
1868	252,054	23.74		200	7.93		87	3.45	
1869	280,000	23.17		183	6.54		130	4.64	
• 1870	298,000	24.52		268	8.99		164	5.50	
1871	334,270	20.87		204	6.10		196	5.86	
1872	367,396	27.67	23.70	524	14.26	8.4	148	4.03	4.6
1873	380,000	25.16		273	7.18		92	2.42	
1874	395,400	20.29		211	5.34		78	1.97	
1875	407,000	19.41		207	5.09		125	3.07	
1876	420,000	20.41		168	4.00		474	11.29	
1877	439,776	18.24	18.51	159	3.61	4.1	333	7.57	8.2
1878	450,000	16.50		146	3.24		294	6.53	
1879	475,000	18.01		208	4.38		604	12.72	
• 1880	503,298	20.79		171	3.40		930	18.48	
1881	540,000	25.69		568	10.52		609	11.28	
1882	560,000	23.60	21.83	462	8.25	6.8	521	9.30	11.9
1883	600,000	19.26		361	6.02		592	9.87	
1884	630,000	19.80		354	5.62		649	10.30	

TABLE IX.—CITY OF ST. LOUIS, MO.

[Compiled from data furnished by Robert Moore, C. E., St. Louis, or drawn from the *Mayor's Message and Accompanying Documents*, St. Louis, May, 1884.]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid and Typhus Fev.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
c 1866	204,327								
1867	212,360	30.79		194	9.14		106	4.99	
1868	220,700	23.53	26.66	294	13.32	10.4	79	3.58	4.3
1869	229,380	25.65		202	8.81		100	4.36	
* 1870	238,400	28.00		269	11.28		167	7.01	
1871	247,760	21.25		174	7.02		137	5.53	
1872	257,500	31.25	27.17	176	6.83	7.2	142	5.51	5.4
1873	267,620	31.95		167	6.24		139	5.19	
1874	278,140	23.39		131	4.71		109	3.92	
1875	289,070	26.06		131	4.53		232	8.03	
1876	300,430	20.03		103	3.43		324	10.78	
1877	312,240	18.16	20.21	130	4.16	3.5	234	7.49	8.0
1878	324,510	18.50		74	2.28		241	7.43	
1879	337,270	18.29		112	3.32		203	6.02	
c 1880	350,520	18.93		139	3.97		174	4.96	
1881	364,300	23.09		191	5.24		225	6.18	
1882	378,620	20.72	20.56	166	4.38	4.3	288	7.61	9.9
1883	393,500	20.78		158	4.02		687	17.46	
1884	408,965	19.29		166	4.06		541	13.23	

* The population of St. Louis in 1870, according to the U. S. Census, was 310,864, but the enumeration is known to have been fraudulent, and is "of no value whatever." The population here used has been carefully computed on the basis of the U. S. Census of 1860, the city census of 1866, and the U. S. Census of 1880.

TABLE X.—CITY OF NEW ORLEANS, LA.

[Compiled from data furnished by S. S. Herrick, M. D., Secretary State Board of Health of La.; or drawn from Table C., page 196, *Annual Report of the Board of Health of the State of La., 1881*, and various Tables in *The Annual Report of the Board of Health to the General Assembly of the State of Louisiana, 1883-4.*]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1844	86,632	51.66		44	5.08				
1845	89,261	29.20		76	8.51				
1847	108,699	67.18	60.62	233	21.43	13.8	1		
1848	115,503	76.92		223	19.30				
1849	122,511	78.13		178	14.53				
1850	129,747	58.96		103	8.00				
1851	138,599	52.48		103	7.43				
1852	147,441	56.82	66.86			8.3			
1853	154,132	99.18		146	9.47				
1854									
1855	158,980	47.21							
1856	161,404	33.05		115	7.12				
1857	163,828	31.88	43.97	118	7.20	9.6			10.5
1858	165,450	68.73		189	11.42		95	5.74	
1859	166,500	39.00		214	12.85		253	15.20	
1860	168,670	43.52		163	9.66		145	8.60	
1861	169,907	30.10		102	6.00		78	4.59	
1862			40.91			11.5			10.9
1863	172,361	40.67		257	14.91		188	10.91	
1864	173,588	49.34		268	15.44		337	19.41	
1865	174,815	38.32		154	8.81		104	5.95	
1866	178,042	41.23		116	6.51		98	5.50	
1867	181,269	52.88	37.69	119	6.56	5.7	31	1.71	3.0
1868	184,496	26.25		58	3.14		16	.87	
1869	187,723	29.79		63	3.36		19	1.01	
1870	191,418	36.26		80	4.18		19	1.00	
1871	193,412	28.92		71	3.67		14	.72	
1872	196,406	31.17	33.57	67	3.41	3.8	39	1.99	2.2
1873	198,900	37.73		57	2.86		46	2.31	
1874	201,394	33.75		95	4.72		102	5.06	
1875	203,888	30.00		57	2.80		69	3.38	
1876	206,382	30.32		53	2.57		40	1.94	
1877	208,870	32.11	33.04	69	3.30	2.5	33	1.58	2.5
1878	211,371	48.81		44	2.08		59	2.79	
1879	213,865	23.94		33	1.54		58	2.71	
1880	216,143	25.98		52	2.41		81	3.75	
1881	218,850	29.08		66	3.01		92	4.20	
1882	221,593	26.60	29.11	74	3.34	2.7	42	1.90	3.4
1883	224,370	33.32		51	2.27		67	2.99	
1884	227,173	30.55		56	2.46		94	4.14	

TABLE XI.—ENGLAND.

[Data furnished by the English Registrar-General, London, England.]

Year.	Population.	Annual Death-rate from all Causes per 1,000 Living.		Fever.*			Diphtheria and Croup.	
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.
1850	17,773,324	20.8		15,374	8.66			
1851		22.0		17,930	10.15			
1852		22.3	22.3	18,641	10.41	10.0		
1853		22.9		18,554	19.25			
1854		23.5		18,893	10.28			
1855	18,829,000	22.6		16,470	8.89		4,804	
1856		20.5		16,182	8.60		5,810	
1857		21.8	22.1	19,016	9.97	9.0	6,862	
1858		23.1		17,883	9.28		12,826	
1859		22.4		15,877	8.14		15,820	
1860	19,902,713	21.2		13,012	6.63		9,592	
1861		21.6		15,440	7.76		8,914	
1862		21.4	22.2	18,721	9.31	8.5	10,570	
1863		23.0		18,017	8.86		13,464	
1864		23.7		20,106	9.77		12,241	
1865	21,145,151	23.2		23,034	11.09		10,066	
1866		23.4		21,104	10.05		8,168	
1867		21.7	22.5	16,862	7.95	9.3	6,987	
1868		21.8		19,701	9.17		7,504	
1869		22.3		18,390	8.46		7,084	
1870	22,501,316	22.9		17,910	8.04		7,001	
1871		22.6		15,790	6.99		6,641	
1872		21.3	22.0	14,020	6.12	6.6	5,792	
1873		21.0		13,553	5.85		6,713	
1874		22.2		13,735	5.86		8,570	
1875	24,042,974	22.7		13,063	5.48		7,957	
1876		20.9		10,746	4.45		7,355	
1877		20.3	21.2	9,987	4.08	4.3	6,641	
1878		21.6		10,417	4.21		7,559	
1879		20.7		7,933	3.17		6,627	
1880	25,708,666	20.5		8,794	3.42		6,381	
1881		18.9		7,240	2.78			
1882		19.6	19.6	7,992	3.03			
1883		19.5		7,918	2.96			
1884		19.6					4,696	

* Includes typhus, typhoid, simple and ill-defined fevers.

TABLE XII.—CITY OF LONDON.

[Furnished by the English Registrar-General, London, England.]

Year.	Population.	Annual Death-rate from all Causes per 1,000 Living.		Fever.*			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1838				4,078	23.1				
1839				1,819	10.1				
1840		25.0		1,262	6.9				
1841		24.1		1,151	6.1	10.2			
1842		23.6	24.5	1,184	6.2				
1843		24.8		2,094	10.7				
1844		25.1		1,721	8.4				
1845		23.3		1,324	6.4				
1846		23.4		1,838	8.7				
1847		26.8	25.9	3,297	15.0	11.5			
1848		25.1		3,685	16.4				
1849		30.1		2,564	11.2				
1850		21.0		2,092	8.7				
1851		23.4		2,374	10.0				
1852		22.5	24.1	2,183	9.0	9.9			
1853		24.4		2,617	10.6				
1854		29.4		2,816	11.2				
1855		24.3		2,460	9.7				
1856		22.0		2,717	10.5				
1857		22.4	23.1	2,195	8.3	8.5			
1858		23.9		1,919	7.2				
1859		22.7		1,840	6.8		773	2.8	
1860		22.4		1,476	5.3		484	1.7	
1861		23.2		1,848	6.6		674	2.4	
1862		23.9	24.0	3,673	12.8	9.5	730	2.6	1.7
1863		24.5		2,871	9.9		799	2.8	
1864		26.4		3,782	12.8		611	2.1	
1865		24.5		3,217	10.7		431	1.4	
1866		26.5		2,688	8.8		462	1.5	
1867		23.0	24.4	2,184	7.1	8.4	447	1.4	1.4
1868		23.5		2,468	7.9		495	1.6	
1869		24.6		2,400	7.6		340	1.1	
1870		24.1		2,018	6.3		334	1.0	
1871	3,254,260	24.6		1,691	5.2		344	1.1	
1872		21.4	23.0	1,303	3.9	4.9	267	0.8	1.0
1873		22.4		1,510	4.5		320	0.9	
1874		22.4		1,528	4.5		419	1.2	
1875		23.5		1,217	3.5		581	1.7	
1876		21.9		1,130	3.2		387	1.1	
1877		21.5	22.5	1,252	3.4	3.3	316	0.9	1.4
1878		23.1		1,381	3.7		566	1.6	
1879		22.6		1,080	2.9		575	1.5	
1880		21.7		910	2.5		544	1.4	
1881	3,816,483	21.5		1,197	3.0		657	1.7	
1882		21.4		1,123	2.8	2.7	857	2.2	2.0
1883		20.4		1,120	2.8		952	2.4	
1884	4,019,361			1,045	2.6		973	2.4	

* Includes typhus, typhoid, simple, and ill-defined fevers.

TABLE XIII.—CITY OF PARIS.

[Compiled from data furnished by Dr. Prosper de Pietra-Santa, General Secretary of the French Society of Hygiene, and Ed. of the *Journal d' Hygiène*. These figures are from official sources and differ only slightly from those given by Durand-Claye in "*L' épidémie de fièvre typhoïde à Paris en 1882*," and by Bertillon in *Bull. de Statistique Municipal*.]

Year.	Population, garrison included (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
◦ 1846	1,053,897								
1850	1,053,897	24.53							
◦ 1851	1,053,262	26.19							
1852	1,077,479	25.88	28.64						
1853	1,101,696	30.19							
1854	1,125,913	36.39		2,077	18.45		977	8.68	
1855	1,150,130	31.31		3,243	28.20		970	8.43	
◦ 1856	1,174,346	25.50		1,537	13.09		842	7.17	
1857	1,199,346	27.72	27.60						
1858	1,224,346	27.25							
1859	1,249,346	26.23							
1860	1,664,346	24.79							
◦ 1861 *	1,696,141	25.74							
1862	1,721,968	24.50	24.94						
1863	1,747,795	24.36							
1864	1,773,622	25.32							
1865	1,799,449	28.50		1,161	6.45		971	5.39	
◦ 1866	1,825,274	26.15		967	5.29		815	4.47	
1867	1,851,274	23.45	25.33	925	4.99	5.5	704	3.80	4.4
1868	1,877,274	24.45		988	5.26		782	4.17	
1869	1,903,274	24.10		1,089	5.67		811	4.26	
1870	1,860,142	39.55		2,624	14.11		883	4.75	
1871†	1,817,000	47.75		‡ 4,467	24.58		915	5.04	
◦ 1872	1,851,792	21.41	30.41	1,007	5.44	10.8	1,149	6.20	5.5
1873	1,886,045	22.13		1,021	5.41		1,174	6.22	
1874	1,920,298	21.23		823	4.29		1,008	5.25	
1875	1,954,551	23.30		1,048	5.36		1,316	6.73	
◦ 1876	1,988,806	24.43		2,032	10.22		1,550	7.79	
1877	2,039,030	23.30	23.56	1,201	5.89	6.2	2,364	11.59	8.8
1878	2,089,254	22.90		857	4.10		1,995	9.55	
1879	2,139,478	23.88		1,121	5.24		1,783	8.33	
1880	2,189,702	26.24		2,120	9.68		2,153	9.83	
◦ 1881	2,239,928	25.50		2,121	9.47		2,322	10.37	
1882	2,270,910	25.80	25.21	3,352	14.76	9.9	2,390	10.52	9.6
1883	2,318,910	24.40		2,046	8.82		1,953	8.42	
1884	2,363,910	24.10		1,619	6.85		2,091	8.85	

* Suburb annexed in 1860. † Year of the siege. ‡ January, 1,495 deaths; February, 1,141.

NOTE.—According to Dr. de Fournes the mean annual death-rate of France during the ten years, 1875–84, was 22.29 per 1,000 living.

TABLE XIV.—CITY OF MARSEILLES.

[Compiled from data furnished by Dr. Albenois, Director of the Bureau of Demography and Medical Statistics of the city of Marseilles.]

Year.	Population.	Annual Death-rate per 1,000 Living.‡	Typhoid Fever.			Diphtheria.		
			Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1880*			423	11.75		413	11.47	
1881			449	12.47		395	10.97	
1882		31.05+	563	15.63	12.8	401	11.14	10.7
1883	360,099		501	13.91		367	10.19	
1884			377	10.47		346	9.61	

* No reliable statistics prior to 1880. + Mean of five years. ‡ From all Causes.

TABLE XV.—CITY OF TURIN, ITALY.

[Compiled from *Annali di Statistica, Serie 3ª, Vol. 9, Roma, 1884*, and from data furnished by L. Bodio, Director General of Statistics of the kingdom of Italy.]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1856				87			16		
1857				111			39		
1858				95			86		
1859				144			81		
1860	203,922	27.44		126	6.18		70	3.43	
1861	204,715	28.41		207	10.11		59	2.88	
1862	205,508	31.13	30.10	386	18.78	11.0	226	11.00	5.5
1863	206,301	30.04		208	10.08		106	5.14	
1864	207,094	33.49		202	9.75		104	5.02	
1865	207,887	29.62		193	9.28		71	3.42	
1866	208,680	30.25		202	9.68		94	4.50	
1867	209,473	31.48	29.51	253	12.08	11.7	104	4.96	4.5
1868	210,266	28.12		301	14.32		100	4.76	
1869	211,059	28.07		274	12.98		101	4.79	
1870	211,852	29.01		216	10.20		232	10.95	
1871	212,644	27.79		237	11.15		177	8.32	
1872	216,663	26.51	26.92	198	9.14	11.2	151	6.97	8.1
1873	220,682	26.24		274	12.42		154	6.98	
1874	224,701	25.05		295	13.13		161	7.17	
1875	228,720	24.71		308	13.47		175	7.65	
1876	232,739	23.07		246	10.57		193	8.29	
1877	236,758	24.62	24.27	329	13.89	12.6	191	8.07	7.9
1878	240,777	25.80		322	13.37		184	7.64	
1879	244,796	23.14		287	11.72		187	7.64	
1880	248,815	23.99		263	10.57		106	4.26	
1881	252,832	28.00		271	10.72		404	15.98	
1882	256,851	26.97	27.99	261	10.16	9.5	383	14.91	10.7
1883	253,559	28.88		165	6.51		273	10.77	
1884	253,198	32.10		244	9.64		196	7.74	

TABLE XVI.—CITY OF PALERMO, ITALY.

[Compiled from *Annali di Statistica, Serie 3ª, Vol. 9, Roma, 1884*, and from data furnished by L. Bodio, Director General of Statistics of the Kingdom of Italy.]

Year.	Population [Comune.] (Estimated or enumerated.)	Annual Death-rate per 1,000 § Living.	Typhoid Fever.			Diphtheria.		
			Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
* 1861	194,463							
* 1871	219,348							
* 1881	244,991	25.02	339	13.84		234	9.55	
1882	247,550	25.24	356	14.38	13.1	280	11.31	8.6
1883	250,339	24.04	326	13.02		180	7.20	
1884	253,339	24.33	282	11.13		161	6.40	

TABLE XVII.—THE LARGER ITALIAN CITIES—COMPARATIVE VIEW.

[Compiled from *Annali di Statistica, Serie 3ª, Vol. 9, Roma, 1884*, and from data furnished by L. Bodio, Director General of of Statistics of the Kingdom of Italy.]

Cities.	Estimated Population, Dec. 31,		Annual Death Rate per 1,000 Living.§ Average of 7 years 1878-84.	Deaths per 10,000 Inhabitants.							
				Typhoid Fever.				Diphtheria.†			
	1883.	1884.		1881.	1882.	1883.	1884.	1881.†	1882.†	1883.	1884.
Naples	495,788	490,555	32.84	9.5	6.1	6.4	6.5	7.6	8.7	5.7	4.0
Milan	323,568	325,525	29.78	11.2	9.6	9.3	7.7	11.9	11.9	8.8	5.8
Rome	301,370	302,197	29.02	5.1	3.6	4.6	4.8	7.4	9.1	5.3	3.3
Turin	253,559	253,198	26.72	10.7	10.3	6.5	9.6	16.0	15.1	10.8	7.7
Palermo	250,330	253,339	24.49	13.8	14.5	13.0	11.1	9.6	11.4	7.2	6.4
Genoa	180,859	181,013	27.31	7.5	4.6	5.8	4.6	11.3	5.5	3.5	3.7
Florence	168,052	168,407	30.77	.....	9.2	8.6	7.1	.....	7.9	8.2	7.4
Venice	134,480	134,610	29.57	4.9	8.4	5.5	4.3	5.3	4.6	2.2	1.3
Messina	129,452	131,240	26.73	9.6	9.8	7.7	10.1	32.3	15.3	13.1	14.9
Bologna	122,887	122,306	30.28	8.4	7.3	7.2	4.7	6.3	4.6	9.4	10.5
Catania	102,117	103,715	30.52	*17.9	18.2	17.9	17.5	16.3	9.6	13.6	3.6
Leghorn	98,677	99,053	25.11	8.3	12.2	12.6	12.3	9.8	8.7	4.9	5.0
Ferrara	75,766	76,421	‡ 33.77	.....	.....	14.9	7.9	.....	.....	45.3	24.6

* 1878..... 28.56.
1879..... 26.03.
1880..... 23.58.

† Croup is included in 1881 and in 1882.

‡ Mean of biennium, 1883-4.

§ From all Causes.

TABLE XVIII.—CITY OF FRANKFORT AM MAIN.

[Data furnished by Drs. G. Varrentrapp and Alex. Spiess, of Frankfort am Main.]

Year.	Population (census years.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1850									
1851		16.40		48	7.3				
1852	67,332	16.60	16.50	65	9.7	8.1	3	0.5	0.1
1853		16.30		60	8.9		0		
1854		16.70		45	6.6		0		
1855	68,851	17.50		68	9.9		0		
1856		16.60		59	8.5		0		
1857		18.20	17.44	71	10.0	9.1	0		0.1
1858	72,783	18.40		46	6.4		4	0.6	
1859		16.50		80	10.9		1	0.1	
1860		15.90		59	7.9		0	----	
1861	75,930	17.80		50	6.6		6	0.8	
1862		18.60	17.42	37	4.7	5.0	3	0.3	0.7
1863		17.00		22	2.8		5	0.6	
1864	82,334	17.80		25	3.1		11	1.7	
1865		18.80		67	8.0		20	2.4	
1866		19.50		56	6.8		17	2.1	
1867	78,277	18.90	19.70	34	4.4	6.1	20	2.6	2.2
1868		20.60		58	7.2		20	2.5	
1869		20.70		36	4.3		12	1.4	
1870		21.50		51	5.9		9	1.0	
1871	91,040	24.50		53	5.9		11	1.2	
1872		19.80	21.48	57	6.1	7.1	13	1.3	1.5
1873		20.80		63	6.5		20	2.1	
1874		20.80		112	11.3		13	1.3	
1875	103,136	20.50		45	4.2		21	2.1	
1876		20.40		35	3.3		49	4.7	
1877		19.70	20.40	16	1.3	2.6	74	6.1	4.3
1878		20.70		23	1.8		69	5.5	
1879		21.00		28	2.2		42	3.2	
1880	134,800	20.50		27	2.0		23	1.7	
1881		19.30		16	1.2		38	2.8	
1882		20.40	20.04	22	1.6	1.4	40	2.9	3.0
1883		19.60		13	0.9		35	2.5	
1884	146,600	20.40		18	1.2		72	4.9	

TABLE XIX.—CITY OF MUNICH.

[Compiled from data furnished by Dr. Max Von Pettenkofer, of Munich.]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.*		Typhoid Fever.			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1851	125,304			123	9.82				
1852	127,006			152	11.97	12.5			
1853	128,708			235	18.26				
1854	130,410			293	22.47				
1855	132,112			253	19.15				
1856	133,847			384	28.69				
1857	135,733			392	28.88	25.4			
1858	137,095			453	33.04				
1859	140,624			240	17.07				
1860	144,384			153	10.60				
1861	148,206			172	11.61				
1862	154,602			300	19.40	16.2			
1863	160,896			252	15.66				
1864	167,054			397	23.76				
1865	168,036			338	20.11				
1866	169,018			342	20.23				
1867	170,000			88	5.18	13.0			
1868	170,000	32.72		130	7.65		267	15.71	
1869	170,000	33.76		201	11.82		289	17.00	
1870	170,000	36.88		193	11.35		196	11.53	
1871	170,000	42.28		220	12.94		209	12.29	
1872	173,000	43.17	41.55	407	23.53	15.3	146	8.44	10.2
1873	178,000	44.83		228	12.81		184	10.34	
1874	184,000	40.58		289	15.71		155	8.42	
1875	190,000	36.52		225	11.84		209	11.00	
1876	196,000	34.85		130	6.63		222	11.33	
1877	† 208,000	35.13	35.82	173	8.32	8.6	210	10.10	11.9
1878	214,000	36.02		116	5.42		298	13.92	
1879	221,000	36.57		233	10.54		293	13.26	
1880	227,000	34.74		147	6.48		367	16.17	
1881	235,000	32.49		43	1.84		394	16.91	
1882	239,000	30.42	31.67	42	1.76	2.7	263	11.00	12.5
1883	245,000	31.33		45	1.83		272	11.10	
1884	251,000	29.36		35	1.39		182	7.25	

* The annual death rate of Munich is increased by an excessive mortality among children.
† Jan. 1, 1877, the suburb Sendling was incorporated.

TABLE XX.—CITY OF DRESDEN.

[Compiled from *Annali di Statistica, Serie 3ª, Vol. 9º Roma, 1884*; and from *Veröff des K. D. Gesundheitsamtes, 1884 and 1885.*]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1850	97,347								
1851	100,715								
1852	104,199								
1853	105,761								
1854	107,347								
1855	108,966								
1856	111,820								
1857	114,749								
1858	117,750								
1859	121,118								
1860	124,582								
1861	128,152								
1862	133,765								
1863	139,624								
1864	145,728								
1865	149,080								
1866	152,509								
1867	156,024								
1868	161,032	31.29							
1869	166,200	28.26							
1870	171,534	30.40							
1871	177,040	32.15							
1872	181,899	28.52	28.44						
1873	186,892	26.81							
1874	192,023	24.31							
1875	197,295	25.30		42	2.13		143	7.25	
1876	201,790	24.72		51	2.53		158	7.83	
1877	206,387	24.50	24.58	54	2.62	2.1	198	9.59	8.5
1878	211,089	24.40		35	1.66		217	10.28	
1879	215,898	23.97		37	1.71		159	7.36	
1880	220,818	24.81		55	2.49		284	12.86	
1881	224,034	25.07		41	1.83		381	17.01	
1882	227,250	25.00	25.35	33	1.45	2.0	570	25.08	19.2
1883	233,600	25.60		54	2.31		495	21.19	
1884	236,000	26.27		42	1.78		467	19.79	

TABLE XXI.—CITY OF LEIPSIC.*

[Compiled from *Annali di Statistica, Serie 3ª, Vol. 9, Roma, 1884*, and from *Veröff. des K. D. Gesundheitsamtes, 1884 and 1885.*]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1850	63,884	30.34							
1851	65,334	25.21							
1852	66,844	25.42	25.00						
1853	67,851	22.61							
1854	68,858	21.41							
1855	69,830	23.13							
1856	71,317	23.84							
1857	72,804	26.11	23.72						
1858	74,336	23.12							
1859	75,764	22.42							
1860	77,192	20.18							
1861	78,614	23.00							
1862	80,247	22.12	22.94						
1863	81,880	24.32							
1864	85,530	25.10							
1865	87,387	25.18							
1866	89,244	44.14							
1867	91,121	21.63	27.30						
1868	95,110	23.60							
1869	99,099	21.94							
1870	103,088	23.06							
1871	107,257	34.36							
1872	112,372	22.73	25.24	30	2.67		146	12.99	
1873	117,487	22.67		23	1.96		182	15.49	
1874	122,602	22.80		29	2.37		130	10.60	
1875	127,813	24.54		33	2.58		175	13.69	
1876	132,151	22.85		39	2.95		100	7.57	
1877	136,489	23.43	23.39	24	1.76	2.4	77	5.64	8.9
1878	140,827	22.60		33	2.34		125	8.88	
1879	145,165	23.55		33	2.27		129	8.89	
1880	149,442	24.27		34	2.28		103	6.89	
1881	153,780	22.23		55	3.58		73	4.75	
1882	158,118	20.84	23.49	33	2.09	2.5	121	7.65	12.3
1883	160,296	24.39		38	2.37		286	17.84	
1884	164,636	25.72		37	2.25		399	24.24	

* Leipsic has an elaborate system of under-ground drains for the removal of rain-water and house slops. The sewage passes into vaults, being carefully excluded from these drains. The vaults are usually situated in the yards of the houses, have carefully cemented sides and bottoms, and are cleaned by excavating apparatus about once in four weeks. There are very few wells in the city. From some of these the water was formerly sold at so much per glass. There is a general supply of filtered river water.

TABLE XXII.—CITY OF BERLIN, GERMANY.

[Compiled from data furnished by Dr. R. B. Boeckh, Director of the Bureau of Statistics of the City of Berlin, or drawn from *Annali di Statistica Serie 3ª, Vol. 9, Roma, 1884, and from Veröf. des K. D. Gesundheitsamtes, Berlin, 1883, 1884, and 1885.*]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes (Except Still-born) per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1850	415,566	25.30							
1851	421,560	23.14							
1852	422,961	25.58	25.19						
1853	423,524	27.84							
1854	427,474	24.11		342	8.00				
1855	431,817	28.55		483	11.18				
1856	438,127	24.85		397	9.06				
1857	445,776	28.41	26.80	536	12.02	10.4			
1858	454,083	26.11		426	9.38				
1859	466,690	26.06		490	10.49				
1860	484,076	22.70		371	7.66				
1861	538,051	26.39		440	8.17				
1862	557,385	25.20	26.33	467	8.37	8.0			
1863	581,947	28.31		488	8.38				
1864	614,411	29.05		459	7.47				
1865	645,078	31.95		693	10.74				
1866	661,641	39.76		599	9.05				
1867	684,391	27.28	32.07	485	7.09	8.8			
1868	716,088	32.86		725	10.12				
1869	746,103	28.52		513	6.87				
1870	768,871	31.28		594	7.72				
1871	799,519	38.86		739	9.24		1,479	18.50	
1872	844,379	31.49	32.37	1,208	14.30	9.7	1,441	17.07	15.7
1873	882,316	30.00		859	9.73		1,414	16.02	
1874	916,449	30.20		691	7.54		1,054	11.50	
1875	948,534	32.92		805	8.49		1,595	16.82	
1876	981,118	29.75		623	6.35		1,733	17.66	
1877	1,010,946	29.66	29.87	612	6.05	5.4	1,091	10.79	14.4
1878	1,039,447	29.47		326	3.13		1,447	13.92	
1879	1,071,886	27.56		296	2.76		1,355	12.64	
1880	1,106,366	29.67		506	4.57		1,422	12.85	
1881	1,139,995	27.24		340	2.98		1,778	15.60	
1882	1,174,227	25.95	27.75	356	3.03	2.9	2,134	18.17	18.5
1883	1,209,232	28.99		221	1.83		2,932	24.25	
1884	1,224,794	26.88		241	1.97		2,640	21.55	

TABLE XXIII.—CITY OF BRESLAU, GERMANY.

[Compiled from data furnished by Dr. Neefe, of the Statistical Bureau of Breslau, or taken from *Annali di Statistica, Serie 3ª, Vol. 9, Roma, 1884.*]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1850	114,500	25.46							
1851	117,866	31.27							
1852	121,052	33.88	31.38						
1853	123,343	35.25							
1854	126,142	31.06							
1855	127,090	42.41							
1856	129,417	34.62							
1857	132,398	31.76	33.81						
1858	135,661	32.17							
1859	138,898	28.07							
1860	142,240	26.35							
1861	145,598	25.38							
1862	151,798	28.12	28.47						
1863	157,437	34.01		226	14.35		108	6.86	
1864	163,919	28.49		182	11.10		47	2.87	
1865	168,618	28.03		208	12.34		54	3.20	
1866	168,201	* 63.00		256	15.20		106	6.30	
1867	169,502	† 35.00	38.41	187	11.00	11.3	139	8.20	5.8
1868	189,206	32.80		197	10.40		126	6.66	
1869	194,911	33.20		148	7.60		87	4.46	
1870	200,986	30.60		123	6.10		56	2.79	
1871	205,912	‡ 40.70		163	7.90		115	5.58	
1872	211,330	§ 33.90	33.28	168	7.90	6.4	90	4.26	3.7
1873	218,900	31.60		113	5.20		65	2.97	
1874	226,867	29.60		113	5.00		66	2.91	
1875	235,187	31.10		115	4.90		127	5.40	
1876	242,857	33.10		133	5.50		157	6.47	
1877	250,529	30.30	31.54	94	3.89	4.3	155	6.19	5.2
1878	257,834	31.90		105	4.10		106	4.11	
1879	264,536	31.30		86	3.30		105	3.97	
1880	270,335	32.60		107	4.00		135	4.99	
1881	276,483	32.30		101	3.70		158	5.71	
1882	282,569	31.50	31.86	80	2.80	3.3	299	10.58	8.2
1883	287,895	31.20		86	3.00		325	11.22	
1884	292,753	31.70		91	3.10		244	8.33	

* 4,328 deaths from Asiatic Cholera.
† 535 deaths from Asiatic Cholera.
‡ 752 deaths from Small-pox.
§ 597 deaths from Small-pox.
‖ Population increased 14,417 by the annexation of suburbs.

TABLE XXIV.—DISTRICT OF HAMBURG.

[The city of Hamburg includes 9-10ths of the population. Data furnished by Dr. Koch, der Vorstand des Statistischen Bureaus der Steuer Deputation, Hamburg.]

Year.	Population (middle of each Year.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1870									
1871									
1872	346,210	26.12	27.22	229	6.60	5.7	294	8.50	9.2
1873	358,620	29.49		189	5.30		341	9.50	
1874	371,040	26.04		193	5.20		352	9.50	
1875	383,450	25.62		203	5.30		325	8.50	
1876	396,230	24.49		137	3.50		253	6.40	
1877	409,280	24.89	25.25	118	2.90	3.6	193	4.70	6.4
1878	422,330	25.84		160	3.80		263	6.20	
1879	435,380	25.42		105	2.40		269	6.20	
1880	448,430	24.95		112	2.50		316	7.00	
1881	458,320	24.31		134	2.90		307	6.70	
1882	469,540	23.99	24.79	123	2.60	2.6	390	8.30	7.8
1883	483,570	25.39		118	2.40		366	7.60	
1884	497,400	25.29		127	2.60		463	9.30	

TABLE XXV.—CITY OF DANTZIC (INSIDE OF THE FORTIFICATION.)

[From *Centralblatt für allgemeine Gesundheitspflege*, IV Jahrgang, erstes Heft, Bonn, 1885.]

Year.	Population (exclusive of Suburbs.)	Annual Death-rate from all Causes per 1,000 Living. *		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1863		36.71			11.2				
1864		31.28			7.7				
1865		33.12			9.8				
1866		49.18			9.6				
1867		34.89	37.34		12.3	10.6			
1868		39.99			12.3				
1869		29.53			8.9				
1870		31.12			7.0				
1871		41.51			11.0				
1872		31.39	31.05		8.0	7.0			
1873		26.50			4.1				
1874		24.74			5.1				
1875		30.81			3.3				
1876		28.66			2.6				
1877		28.86	29.18		2.7	2.5			
1878		29.17			1.9				
1879		28.39			1.8				
1880		31.51			0.8				
1881		26.68			1.4				
1882		29.09	28.57		2.1	1.5			
1883		27.02		9	1.0				
1884	84,458	28.54		20	2.4		4		

* The average annual mortality of 47 years prior to sewerage in 1872 is 35.91.

TABLE XXVI.—POPULATION, BIRTH-RATE, AND DEATH-RATE AND DEATHS FROM TYPHOID FEVER AND DIPHTHERIA IN GERMAN CITIES DURING THE YEAR 1882 AND FOR THE QUINQUENNIUM 1878-82.

[Compiled from *Veröf. des Kaiserlichen Deutschen Gesundheitsamtes*, Berlin, 1883.]

	Cities.	Population, Year 1882.	Births to 1,000 Living.		Deaths to 1,000 Living.		Diphtheria Deaths to 10,000 Living.		Typhoid F. Deaths to 10,000 Living.		Remarks.
			Year, 1882.	Average 5 years, 1878-82.	Year, 1882.	Average, 5 years, 1878-82.	Year, 1882.	Average, 5 years, 1878-82.	Year, 1882.	Average, 5 years, 1878-82.	
Group I.—Cities provided with good water and with sewers or conservancy system.	Frankfort-am-Main	140,000	29.79	31.78	20.36	20.44	2.9	3.8	1.6	1.8	Sewers.
	Munich	238,000	38.11	39.49	30.55	33.46	11.1	14.0	1.8	5.0	Sewers.
	Dresden	227,250	35.90	35.64	25.05	24.74	23.5	14.7	1.5	1.8	Carefully managed conservancy system.
	Danzig	112,119	35.14	36.58	28.01	29.18	10.7	20.5	1.9	2.2	Sewers.
	Breslau	280,200	37.44	38.32	31.75	31.68	5.8	6.1	2.9	3.5	Sewers.
	Stuttgart	108,082	31.88	34.48	22.65	22.83	4.4	10.4	2.4	1.8	Conservancy system.
	Hamburg	416,819	38.45	39.01	24.79	25.62	6.9	7.0	2.2	2.7	Sewers.
	Average		35.24	36.47	26.17	26.85	9.3	10.9	2.0	2.7	
Imperfect sewerage and water-supply.	Elbing	36,405	39.39	38.91	38.57	31.84	88.2	33.8	7.4	8.4	
	Stralsund	30,038	26.63	29.64	25.77	25.44	12.3	7.6	9.3	11.9	
	Stargard i P.	21,546	36.96	36.44	28.58	26.18	25.3	21.3	6.6	8.6	
	Thorn	21,859	31.98	31.28	26.21	26.90	8.2	10.7	8.7	11.7	
	Grandenz	17,466	36.24	36.38	32.29	29.67	9.7	10.3	21.8	20.3	
	Posen	65,900	36.07	36.87	30.99	30.13	9.3	8.4	13.4	13.6	
	Bromberg	35,800	29.13	32.67	22.12	24.34	12.0	15.2	10.6	14.6	
	Beuthen i. O. Schl.	24,483	39.66	41.10	26.22	31.13	8.6	14.1	4.9	8.9	
	Schweidnitz	22,653	30.81	31.42	28.47	29.73	2.2	3.2	7.1	9.2	
	Halberstadt	31,300	39.58	38.12	30.54	27.92	25.6	15.8	5.4	6.1	
	Nordhausen	26,638	32.85	36.90	23.09	24.28	8.3	10.7	9.4	9.9	

Group II.—Cities with	Aschersleben	19,350	39.90	40.07	24.39	25.20	14.5	17.9	7.8	6.8
	Quedlinburg	18,550	35.53	36.53	27.39	26.61	11.3	11.7	8.1	5.8
	Spandau	30,395	38.39	39.98	25.17	25.22	19.4	16.1	4.9	6.1
	Neust-Magdeburg	27,696	50.87	50.21	33.43	36.32	28.3	18.8	7.6	11.3
	Burg b. Magdeburg	16,062	35.36	38.14	24.84	25.96	3.7	13.3	6.8	13.0
	Lüneburg	18,979	30.09	30.99	23.45	23.89	3.7	5.9	15.8	10.4
	Dortmund	68,000	47.96	49.58	28.91	28.81	6.5	9.2	5.4	9.0
	Essen	60,000	45.55	47.12	29.12	29.70	15.3	11.9	5.7	6.2
	Colmar	26,300	34.90	37.19	27.91	29.77	2.4	10.7	4.9	5.6
	Average		36.89	37.98	27.87	27.98	15.7	13.3	8.6	9.8
Comparison of groups I. and II., with the Average of 173 German cities.	Av. of 7 cities, Group I.		35.24	36.47	26.17	26.85	9.3	10.9	2.0	2.7
	Av. of 20 cities, Group II.		36.89	37.98	27.87	27.98	15.7	13.3	8.6	9.8
	Av. of 173 German cities		36.12	37.47	25.83	26.47	10.7	10.1	3.4	4.1

1 Large and crowded cities, population ranging from 108,000 to 416,000.
2 Small cities with population ranging from 16,000 to 60,000.
3 Includes all cities having a population of over 15,000.

TABLE XXVII.—CITY OF VIENNA.

[Compiled from data furnished by the Vienna "*Departement für Statistik.*"]

Year.	Civil population at close of year (estimated or enumerated), exclusive of suburbs.	Annual Death-rate from all Causes, exclusive of Still-births, per 1,000 Living.		Typhoid Fever (includes typhus ex.)			Diphtheria.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1850	423,802	40.09							
c 1851	431,147	39.98							
1852	438,351	40.27	40.56						
1853	445,676	37.89							
1854	453,123	44.56							
1855	460,695	50.51							
1856	468,393	41.28							
c 1857	476,222	39.26	41.53						
1858	486,153	39.37							
1859	496,291	37.21							
1860	506,640	30.52							
1861	517,205	35.14							
1862	527,990	37.21	34.70						
1863	539,000	34.56							
c 1864	550,241	36.07							
1865	561,246	34.01							
1866	572,472	42.44		* 728	12.72				
1867	583,922	31.36	34.71	509	8.72	11.1	72		
1868	595,601	32.49		641	10.76		75		
c 1869	607,514	33.27		733	12.07		95	1.56	
1870	615,820	34.72		594	9.65		126	2.05	
1871	624,240	† 36.30		1,149	18.41		185	2.96	
1872	632,775	38.98	35.58	765	12.09	11.5	213	3.37	2.6
1873	641,426	38.27		742	11.57		139	2.17	
1874	650,196	29.73		375	5.77		163	2.51	
1875	659,086	30.07		502	7.62		237	3.60	
1876	668,097	31.53		272	4.07		678	10.15	
1877	677,232	30.02	30.29	384	† 5.51	4.6	819	12.09	10.1
1878	686,491	30.63		233	3.30		990	14.42	
1879	695,877	29.42		194	2.71		695	9.99	
c 1880	704,756	28.22		171	2.36		466	6.61	
1881	715,047	29.32		171	2.19		383	5.36	
1882	724,824	28.99	28.26	187	2.51	2.1	332	4.58	4.2
1883	733,879	28.11		157	2.08		201	2.74	
1884	743,852	26.65		95	1.24		144	1.94	

* No reliable data prior to 1866.

† In computing the general death-rate after 1871, and the typhoid fever rate after 1876, about 20,000 should in each case be added to the civil population for the military, the deaths of military persons being included since these dates.

TABLE XXVIII.—CITY OF BUDAPESTH.

[Compiled from data furnished by Dr. Joseph Körösi, Director of the Bureau of Statistics of Budapesth. See also *Annali di Statistica, Serie 3ª, Vol. 9, Roma, 1884.*]

Year.	Population (estimated or enumerated) exclusive of Military.	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
• 1870*	202,587	42.71							
1871	206,807	45.61							
1872	211,022	44.90	46.04	293	13.88	16.0	129	6.11	6.9
1873	215,243	52.07		432	20.07		141	6.09	
1874	286,399	44.93		405	14.14		215	7.51	
1875	289,938	41.48		307	10.59		289	9.97	
1876	293,479	41.89		283	9.64		428	14.58	
• 1877†	303,416	39.80	39.25	436	13.74	9.8	569	18.75	15.2
1878	319,740	38.60		297	8.90		664	20.77	
1879	336,064	34.70		221	6.31		394	11.72	
• 1880	352,388	33.60		231	6.31		335	9.51	
1881	368,712	34.50		344	9.08		416	11.28	
1882	384,996	32.60	32.24	245	6.20	5.8	396	10.29	8.7
1883	401,360	29.90*		172	4.18		246	6.13	
1884	406,258	30.61		135	3.24		253	6.20	

NOTE.—No bureau of statistics until after 1868.

* The data from 1870 to 1873, inclusive, *are for Pesth only.*

† The deaths of military persons are included since 1877. From 1876 to 1880 the military population averaged 13,954; 1881-84, 10,216; which numbers should be added to the civil population of column two in computing the death-rate by years.

TABLE XXIX.—CITY OF BRUSSELS.

[Compiled from data furnished by Dr. E. Janssens, Inspector-in-chief of the Sanitary Service of Brussels.]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1864		27.60		101	6.18		194	11.87	
1865		31.30		80	4.89		206	12.60	
1866	163,434	† 46.30		95	5.81		126	7.71	
1867		27.30	31.96	94	5.75	10.0	124	7.59	8.5
1868		24.70		82	5.02		120	7.34	
1869		‡ 30.20		485	28.53		120	7.06	
1870		§ 28.80		77	4.53		104	6.12	
1871	* 170,000	¶ 35.10		379	22.29		64	3.76	
1872		24.20	28.50	59	3.47	8.6	96	5.65	4.8
1873		27.40		83	4.88		80	4.71	
1874	167,972	27.00		134	7.98		63	3.75	
1875	165,943	28.20		64	3.86		49	2.95	
1876	163,914	§ 28.80		81	4.94		29	1.77	
1877	164,277	§ 28.60	27.34	48	2.92	4.0	37	2.25	2.1
1878	164,640	24.80		64	3.89		28	1.70	
1879	165,003	26.30		70	4.24		30	1.82	
1880	165,366	25.10		67	4.05		21	1.27	
1881	166,848	24.50		59	3.54		25	1.50	
1882	168,330	23.90	25.22	46	2.73	3.3	36	2.14	2.9
1883	169,812	26.60		46	2.71		59	3.47	
1884	171,293	26.00		62	3.62		108	6.30	

* Average population. (Considerable immigration during the Franco-Prussian war.)
† Cholera epidemic.
‡ Typhoid fever epidemic.
§ Small-pox epidemic.
¶ Small-pox and typhoid fever epidemic.

TABLE XXX.—CITY OF ST. PETERSBURG.

Year.	Population.	Annual death-rate* per 1,000 Living.	Typhoid Fever.			Diphtheria.		
			Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1878	669,741	47.10	5,402	† 80.66		655		
1879	669,741	40.00	1,573	† 23.49		382		
1880	669,741	46.10	3,194	† 47.69		355		
1883	929,525	32.38	988	10.63		1,119	12.04	
1884	929,525		860	9.25		749	8.06	

* From all causes.
† Typhus included.

TABLE XXXI.—CITY OF STOCKHOLM.

[Compiled from *Berättelse till Kongl. Medicinalstyrelsen om allmänna Helsotillståndet i Stockholm, under Året, 1884, etc. Dr. Klas Linroth, Stockholm, 1885.*]

Year.	Population (estimated or enumerated.)	Annual Death-rate from all Causes per 1,000 Living.		Typhoid Fever.			Diphtheria and Croup.		
				Total Deaths.	Deaths per 10,000 Living.		Total Deaths.	Deaths per 10,000 Living.	
1860	112,391	30.16							
1861	116,496	32.89					97	8.3	
1862	119,327	38.33	32.97				159	13.3	10.4
1863	124,691	30.70					158	12.7	
1864	128,576	32.76					91	7.1	
1865	133,361	34.31					139	10.4	
1866	138,189	33.53					80	5.8	
1867	140,251	27.59	30.57				52	3.7	5.7
1868	131,400	27.04					46	3.5	
1869	134,650	30.37					68	5.1	
1870	133,598	30.22					27	2.0	
1871	137,052	30.21					44	3.2	
1872	139,255	32.15	34.23				36	2.6	3.8
1873*	140,742	36.36		224	15.8	12.8	68	4.8	
1874	142,766	42.19		139	9.7		90	6.3	
1875	144,305	35.22		139	9.5		49	3.4	
1876	146,845	28.98		74	5.0		56	3.8	
1877	152,825	27.72	27.05	78	5.1	5.5	73	4.8	3.2
1878	160,921	21.56		61	3.8		34	2.1	
1879	160,921	21.78		64	4.0		31	1.9	
1880	162,436	28.79		62	3.8		168	10.3	
1881	167,440	24.41		40	2.4		220	13.1	
1882	174,201	23.94	24.89	66	3.8	3.0	171	9.8	10.9
1883	181,732	23.72		42	2.3		199	11.0	
1884	190,115	23.59		48	2.5		193	10.2	

* Typhoid deaths not separated from typhus prior to 1873.

TABLE XXXII.—CHOLERA EPIDEMICS IN AMERICAN AND EUROPEAN CITIES.

Population (estimated or enumerated).	Deaths per each 10,000 Inhabitants.	Total Deaths.	Years.	Cities.
1,687,641	39.2	6,729	1832-3.	London.
2,206,076	66.2	+ 14,601	1848-9.	
	42.9	10,738	1854.	
	18.4	5,596	1866.	
	106.0	3,772	1849.	Glasgow.
	119.0	3,886	1854.	
	1.6	68	1866.	
810,515	225.8	18,302	1832.	Paris.
1,053,500	182.1	19,184	1849.	
1,113,304	68.5	7,626	1853 4.	
1,803,752	1.3	242	1865.	
1,825,274	30.2	5,509	1866.	
1,886,045	4.5	854	1873.	
2,363,910	4.1	968	1884.	
			1834.	Marseilles.
145,000	151.0	2,189	1835.	
			1837.	
167,872 (year 1846.)			1849.	
215,196 (year 1856.)			1854.	
301,131	64.7	1,949	1865.	
300,000	59.4	1,781	1884.	
35,846	480.0	1,682	1835.	Toulon.
			1842.	
52,947	140.0	765	1849.	
55,459	470.0	2,619	1854.	
65,000	200.9	1,306	1865.	
75,000	335.0	2,500	1884.	
310,393	92.4	2,869	1865.	Madrid.
	122.2	5,300	1836.	Naples.
	317.8	13,800	1837.	
	193.4	8,600	1854.	
	29.2	1,300	1855.	
446,931	52.0	2,301	1865.	
	76.7	3,470	1866.	
	6.6	300	1867.	
	28.1	1,280	1873.	
490,555	141.3	6,933	1884.	
		‡ 24,014	1837.	Palermo.
		5,334	1854.	
201,875	197.5	3,977	1866.	
		?	1867.	
184,932	163.7	3,028	1865.	Brussels.
50,000	400.0	2,000	1848.	Riga.
			1831.	St. Petersburg.
532,240	280.0	15,814	1847.	
532,240	230.0	12,228	1848.	
490,808 (year 1856.)			1853.	
			1865.	
460,000	97.8	4,500	1866.	
			1870-1.	
168,201	257.3	4,328	1866.	Breslau.
169,502	31.6	535	1867.	
			1830.	Berlin.
			1831.	
447,483	35.0	1,595	1848.	
	15.0	671	1850.	
	20.0	940	1853.	
			1854.	
		‖ 5,001	1866.	

Population (estimated or enumerated).	Deaths per each 10,000 Inhabitants.	Total Deaths.	Years.	Cities.
55,000	1,000.0	* 5,500	1832.	New Orleans.
115,503	142.5	1,646	1848.	
122,511	259.3	3,176	1849.	
129,747	111.6	1,448	1850.	
138,599	31.0	430	1851.	
147,441	90.1	1,329	1852.	
154,132	37.9	585	1853.	
		?	1854.	
158,980	55.6	883	1855.	
178,042	72.7	1,294	1866.	
181,269	32.1	581	1867.	
184,496	7.0	129	1868.	
198,900	7.1	142	1873.	
63,471	680.0	4,317	1849.	St. Louis.
77,860	113.0	833	1850.	
83,715	101.0	845	1851.	
90,010	89.0	802	1852.	
104,060	148.0	1,534	1854.	
204,327	173.0	3,527	1866.	
212,360	32.0	684	1867.	
267,620	15.0	392	1873.	
224,613	156.4	3,513	1832.	New York.
246,637	39.4	971	1834.	
405,266	102.4	5,071	1849.	
575,171	65.0	374	1852.	
634,795	39.5	2,509	1854.	
885,107	12.8	1,137	1866.	
899,092	0.3	27	1867.	
18,986	144.3	274	1832.	Brooklyn.
90,774	71.6	650	1849.	
141,256	3.1	58	1852.	
183,938	36.9	678	1854.	
313,800	16.5	517	1866.	
		5	1867.	
		?	1832.	Boston.
133,308	45.8	611	1849.	
154,408	14.1	218	1854.	
195,214	0.6	11	1866.	
		853	1832.	Baltimore.
		71	1834.	
		1	1845.	
		62	1866.	
		4	1877.	
		2	1879.	
193,600	62.0	1,200	1866.	Cincinnati.
		3	1867.	
		16	1872.	
		207	1873.	
4,170 (in 1837.)		§ 300	1833.	Chicago.
27,415	247.3	678	1849.	
29,963	140.2	420	1850.	
38,184	60.2	230	1851.	
46,405	135.8	630	1852.	
62,847	226.6	1,424	1854.	
223,670	44.2	990	1866.	
242,253	0.4	10	1867.	
380,000	0.6	23	1873.	
33,185	268.0	889	1866.	Memphis, Tenn.

* Variously estimated at from 4,000 to 7,000.

§ Estimated. Chicago was incorporated as a village in 1833 and the population at this time was not more than five or six hundred.

+ 14,137 deaths in 1849.

‡ In five weeks.

‖ Deaths up to Oct. 4.

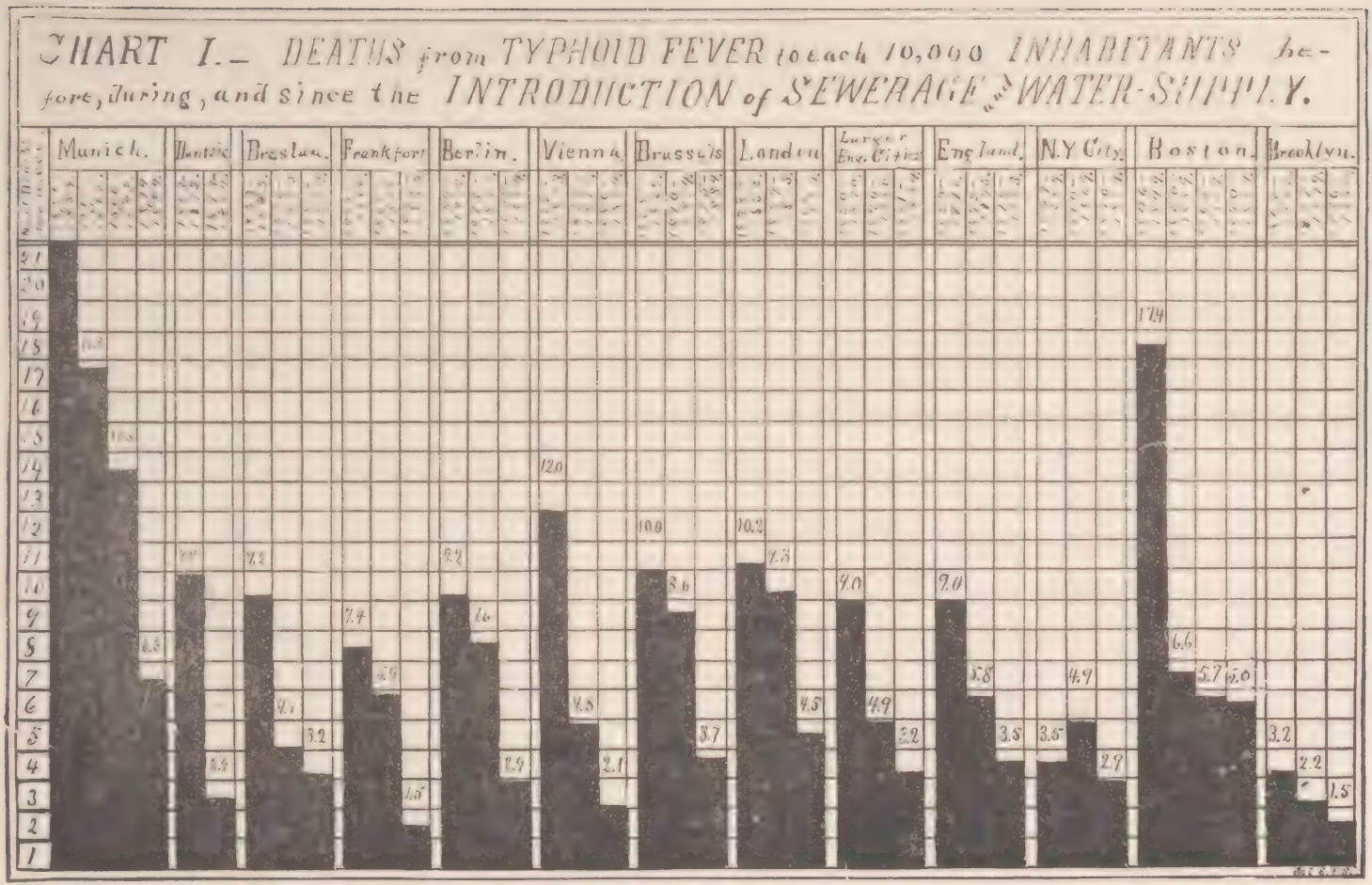
CHART I.— DEATHS from TYPHOID FEVER to each 10,000 INHABITANTS before, during, and since the INTRODUCTION of SEWERAGE and WATER-SUPPLY.
Deaths to each 10,000 Inhabitants
Munich.
Breslau.
Frankfort
Berlin.
Vienna
Brussels
London
Larger Eng. Cities
England.
N.Y. City.
Boston.
Brooklyn.
21
20
19
18
17
16
15
14
13
12
11
10
9
8
7
6
5
4
3
2
1
12.0
10.0
10.2
9.0
9.0
17.4
6.6
5.7
5.0
4.9
4.5
4.1
3.2
3.2
2.2
1.5

CHART II.— DEATHS from TYPHOID FEVER to each 10,000 INHABITANTS in SEWERED and UN-SEWERED CITIES. Av. of 5 yrs., 1880-84,— unless otherwise stated.

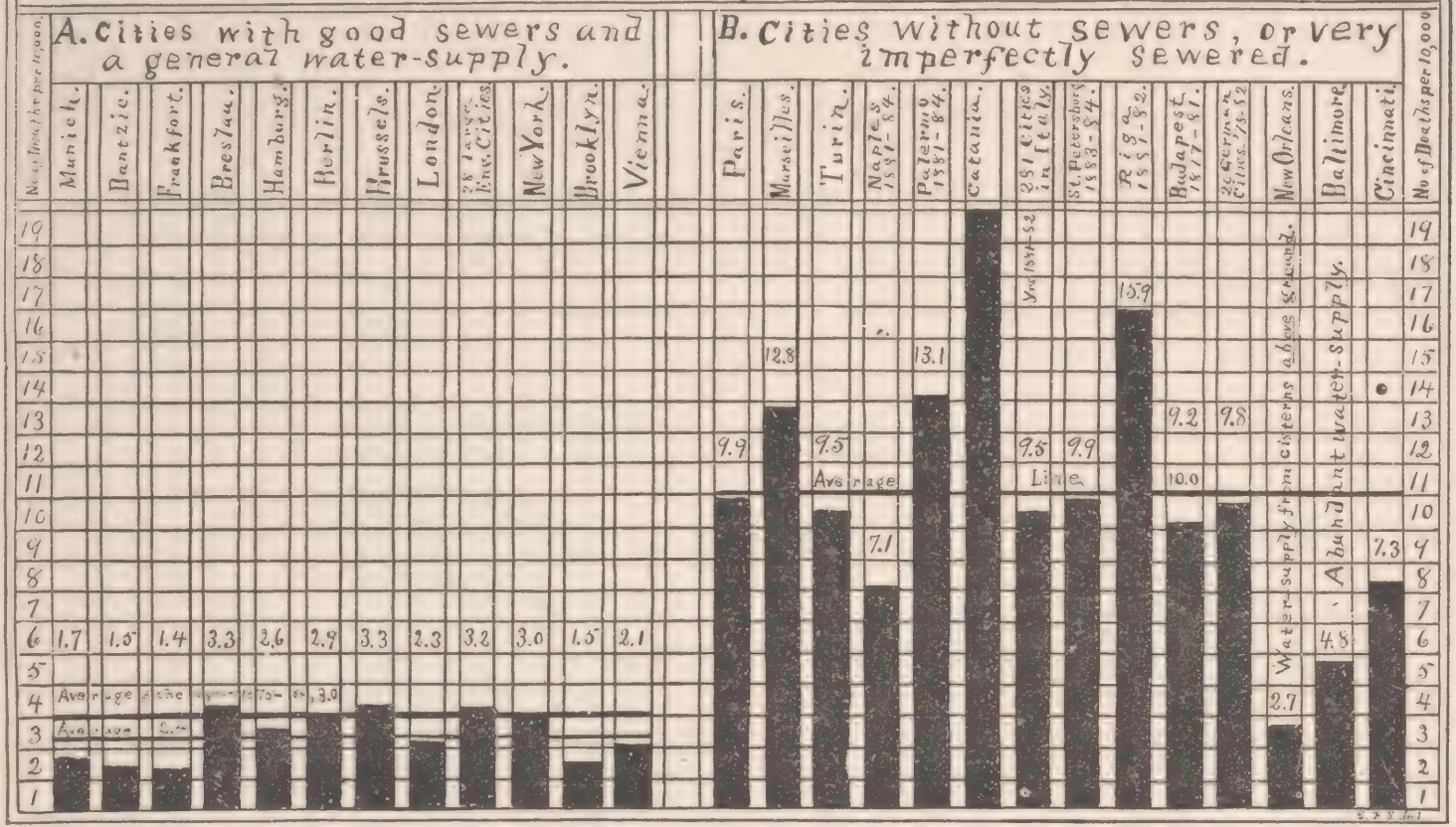

CHART III. Deaths from Asiatic Cholera in American & European Cities, during the epidemic of 1865-6. Designed to show the protective influence of Sewerage & Water-supply.

The cities of Group I. were abundantly supplied with good water and in most cases were also well sewered. The cities of Group II. were incompletely sewered, or entirely destitute of modern sewers and very dirty. Their water-supply was scant or open to infection, being generally very deficient both in quality and in quantity.